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Progress of the precious metal industry in the U.S.

Washington

1893

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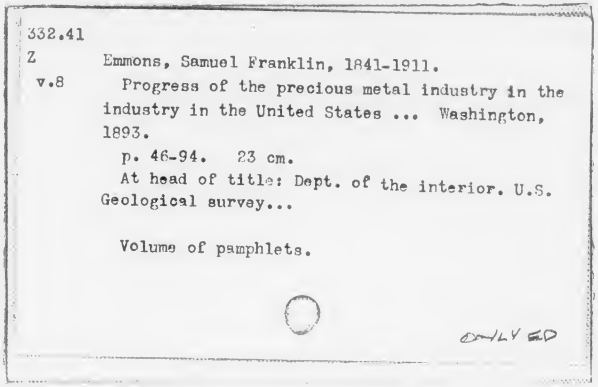
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Emmons, Samuel Franklin, 1841-1911.
Progress of the precious metal industry in the industry in the United States ... Washington, 1893.
p. 46-94. 23 cm.
At head of title: Dept. of the interior. U.S. Geological survey...

Volume of pamphlets.

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TECHNICAL MICROFORM DATA

FILM SIZE: 35mm REDUCTION RATIO: 11:1 IMAGE PLACEMENT: IA (IIA) IB IIB

DATE FILMED: 3-4-98 INITIALS: PB

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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
J. W. POWELL, DIRECTOR

PROGRESS

OF

THE PRECIOUS METAL INDUSTRY IN THE UNITED STATES

BY

S. F. EMMONS

ABSTRACT FROM "MINERAL RESOURCES OF THE UNITED STATES CALENDAR YEAR 1892"—DAVID T. DAY, CHIEF OF THE DIVISION OF MINING STATISTICS AND TECHNOLOGY

WASHINGTON
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PROGRESS OF THE PRECIOUS METAL INDUSTRY IN THE UNITED STATES SINCE 1880.

By S. F. Emmons.

A review of the conditions governing the production of gold and silver in the United States during the past decade is more difficult to make, and, at the best, necessarily more incomplete than that of any other of our mining products, for the reason that the United States Geological Survey was not allowed by Congress to include these metals in its annual investigation of the mineral resources of our country. The Bureau of the Mint, which furnishes the most reliable data as to the aggregate production of these metals, is not so organized as to be able to segregate these products by mining districts, or even by States, in a complete and accurate manner, nor to furnish such technical data as are necessary for an intelligent study of the underlying causes which have governed the variations in the product of these metals.

The reports of the Tenth and Eleventh Censuses show more or less completely the conditions of the mining industry of these metals for the respective years of which they treat, but do not include the intermediate period, nor has the latter Census attempted to continue the geological sketches of the most important mining districts which was inaugurated by the former.

While, therefore, it is manifestly impossible with the available data to give more than the most general outlines of the progress of these industries, the question as to the relative future output of gold and silver is one of such paramount importance at the present time that it seems advisable to make an attempt to trace the causes of their variation in the past decade as well as the imperfection of the data will admit.

Gold is the only important metal that is found in great measure in the native or metallic state, and comparatively free from other metallic combinations. Silver, on the other hand, is almost universally found in nature more or less intimately combined with baser metals from which it must be separated by a relatively expensive process in order to be reduced to the metallic state. Gold, again, is largely produced from placer deposits—detrital gravels and sands resulting from the disintegration of gold-bearing rocks and veins—in which atmospheric agents have concentrated and prepared it for man's use, so that it can be extracted by simple processes requiring but little technical skill or

scientific training. The reduction of silver from its ores, on the other hand, requires in most cases not only the highest degree of technical and scientific knowledge and experience, but to render available any but exceptionally rich ores involves the expenditure of large capital in smelting plants, centrally situated and with easy and cheap railroad transportation to and from mining districts and coal fields.

The history of the development of unexplored regions rich in the precious metals follows with comparative regularity certain general lines. Gold is first discovered in the sands of the streams, and if these lead to rich and readily accessible placer deposits, a "boom" sets in and results in a very rapid increase in gold production, from the fact that large numbers, not necessarily expert miners, can work at them, and no great preliminary expenditure of capital is required. With the rapid exhaustion of the richer and more easily worked placers, many abandon mining altogether; others search for new fields and for the veins from which the gold has been derived, and deep mining gradually replaces placer mining. This, however, is of relatively slow development, requires outside capital, and is more dependent on transportation facilities. Production for a time falls off, and increases again with the discovery of rich mines and consequent attraction of outside capital, which itself increases transportation facilities. This increase in production is slower than that due to the discovery of virgin placers of unusual richness. The prospector, who usually gathers his knowledge of ores not from previous training but from practical experience in the field, searches first for the more readily recognizable gold ores and only as circumstances increase his knowledge for the more complicated and obscure silver-bearing ores. This progression is illustrated in the broad general features of production of the precious metals in the United States. When Whitney wrote his *Metallic Wealth of the United States*, in 1854, the financial conditions of the world were being seriously disturbed by the almost simultaneous development of the placer mines of California and Australia, which together had added at a bound $120,000,000 to the world's annual production of gold without any corresponding increase in the product of silver. At that time and for many years afterwards there was "no proper silver mine" within our territory, and it is hardly to be wondered at that he considered, in the light of the world's experience up to that time, silver to be better adapted for a standard of value than gold, since it appeared to be less susceptible to violent fluctuations in its production.

The production of the precious metals in the United States during the decade 1850–'60 was practically all gold, averaging over $50,000,000 annually, and mostly derived from placers; while of the less than $100,000 average annual product of silver the greater part came from gold alloys.

In the early part of the decade 1860–'70 the gold product fell off to $40,000,000 but increased again to $50,000,000 toward the end, the more

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complicated hydraulic mining replacing placer workings and vein mining becoming gradually more developed. The first great silver producer, the Comstock lode, was opened during this decade, and from this and other smaller bodies of rich silver ore, whose discovery was a more or less direct consequence of its development, the silver product increased gradually during the decade from $1,000,000 to $10,000,000. Toward the end of the decade the first great silver-ore bodies in limestone were discovered, the first smelting works in the western mountain region were established, and the first transcontinental railroad line was built, circumstances which were to have a most important and far-reaching influence upon the mining industry.

During 1870–'80 the mining industry was gradually being established on a more permanent and business-like basis through the introduction of improved methods and machinery and the increase in transportation facilities. Placer mining was almost entirely conducted on the hydraulic system, which involved a considerable investment of outside capital and the concentration of the workings into fewer hands. Prospectors were turning their attention more and more to the discovery of base-metal ores whose principal value is in silver rather than gold, and which, being more likely to develop into great bonanzas like the Comstock, were hence more attractive to capitalists. Gold mining proper settled down to a comparatively regular output, but the gold product of the country was kept up by the Comstock lode, two-fifths of whose bullion value was in gold. This remarkable deposit reached the climax of its production during the decade, contributing during five years an average of $25,000,000 to $30,000,000 annually to the precious-metal product of the country. The silver product during the decade increased steadily from $12,000,000 to $30,000,000, while that of gold fluctuated between $33,000,000 and $50,000,000.

The opening of the decade 1880–'90 witnessed the final transference of the center of activity of mining in the West from the Sierra Nevada to the Rocky mountains. The bonanzas of the Comstock lode had been exhausted, and its deeper workings were soon to be abandoned as unprofitable. The reduction in the silver product caused thereby was more than replaced by the recently discovered silver-lead deposits in limestone of the Leadville district, which, however, carried little or no gold. The ultimate importance of the discovery of these ores, and of the many similar ones since opened as a direct result of the teachings their development has afforded to the mining community, has been shown in the enormous development of the smelting industry, and the concomitant opening of coal fields and the building of railroads in every direction through the mountain region, which, in turn, have stimulated the opening of silver mines carrying mixed or low-grade ores wherever they could be found within reach of railroads.

The characteristic feature has been the increase of railroad facilities throughout the mining region and the enormous development of the smelting industry, which is thus far the highest development of technical

skill applied to the extraction of the metals from their ores. It forms the final step in the progression from the rude pan washing of the placer worker, through the Little Giant and riffle-boxes of the hydraulic miner, to the more or less complicated crushing by stamps or pulverizers and subsequent amalgamation, with or without the addition of chemicals, and aided in special cases by various lixiviation processes. But, without the aid of metallurgical processes, carried on in a scientific manner and aided by large capital, the greater bulk of the ores that have been reduced within the last decade would never have been extracted from their rocky beds.

The decade has been one of great commercial prosperity in our country. Capital has been abundant, and has gone freely into new enterprises. It is only in such times that mining flourishes; for, on account of its hazardous nature, it is the last sought by capital. On the other hand, the investment of capital in railroads and smelting plants is a permanent one, which can not be withdrawn without great loss, and which therefore encourages the investment of other capital in tributary mines to make profitable that which is already invested. It is evident at a glance, therefore, that general industrial conditions have been such as to stimulate mining enterprises during the decade, especially such as require large capital.

Beside these broad general causes, there are in the physical and geological conditions of our various mining regions other causes which have influenced locally the relative production of these metals, and which, if accurately known, might aid in foretelling to a certain degree the probable future of either. In the succeeding pages the writer will endeavor to trace out these underlying causes by giving a summary statement of such general facts in each State or region as available data will afford.

In the first table is given the production of gold and silver for the several States and Territories, as furnished by the reports of the Tenth and Eleventh Censuses, respectively, which, though not absolutely correct, shows sufficiently well the aggregate increase or decrease of either during that period. In this table, on account of the geological unity of their deposits, the products of the States of Maryland, Virginia, North and South Carolina, Tennessee, and Georgia, have been grouped under the general head of Appalachian States, while the as yet comparatively unimportant products of Michigan and Texas are given together as "other States." Later, and at the end of the paragraphs treating of each of these general divisions, are given tables showing the production of each year from 1880 to and including 1892, which have been taken from the reports of the Director of the Mint. Although this segregation is based on estimates that are necessarily not entirely accurate, it gives the best available approximation. (*a*)

a Throughout this paper figures of production are given in coinage, not in commercial values—the coinage values are $20.67 per ounce for gold and $1.2929 for silver—so that the equivalent weight can readily be calculated.

Relative production of gold and silver in 1880 and 1890 (census returns).

States.	Gold.		Silver.		Totals.	
	1880.	1890.	1880.	1890.	1880.	1890.
Alaska	$5,951	$904,650	$51	$11,918	$6,002	$916,568
Arizona	211,965	910,174	2,325,825	2,343,977	2,537,790	3,254,151
California	17,150,941	12,585,782	1,150,887	1,373,807	18,301,828	13,960,529
Colorado	2,699,898	3,883,859	16,540,274	23,757,751	19,240,172	27,641,610
Dakota	3,305,843	3,091,157	70,813	135,331	3,376,656	3,226,488
Idaho	1,479,653	1,884,159	464,559	4,056,482	1,944,203	6,940,641
Montana	1,805,767	3,139,727	2,965,068	17,468,960	4,770,835	20,608,287
Nevada	4,888,242	3,506,226	12,430,667	6,072,241	17,318,909	9,578,536
New Mexico	49,354	815,655	392,347	1,617,578	441,691	2,433,233
Oregon	1,057,701	964,269	27,793	23,582	1,125,494	987,851
Utah	291,587	487,666	4,744,087	9,057,014	5,034,674	9,544,680
Washington	135,800	186,150	1,019	36,891	136,819	222,951
Wyoming	17,321	14,512	.....	.....	17,321	14,512
Appalachian States	224,341	318,261	528	4,688	224,869	322,949
Other States (*a*)	.....	93,868	25,858	437,058	25,858	530,926
Total	33,379,663	32,886,744	41,110,957	66,396,288	74,490,620	99,283,732

a Michigan and Texas.

Product of gold and silver in the United States from 1792.

[The estimate for 1792–1873 is by Dr. R. W. Raymond, United States Mining Commissioner, and since by the Director of the Mint.]

Years.	Total.	Gold.	Silver.
April 2, 1792–July 31, 1834	$14,000,000	$14,000,000	(*a*)
July 31, 1834–Dec. 31, 1844	7,750,000	7,500,000	$250,000
1845	1,058,327	1,008,327	50,000
1846	1,189,357	1,139,357	50,000
1847	939,085	889,085	50,000
1848	10,050,000	10,000,000	50,000
1849	40,050,000	40,000,000	50,000
1850	56,050,000	56,000,000	50,000
1851	55,050,000	55,000,000	50,000
1852	60,050,000	60,000,000	50,000
1853	65,050,000	65,000,000	50,000
1854	60,050,000	60,000,000	50,000
1855	55,050,000	55,000,000	50,000
1856	55,050,000	55,000,000	50,000
1857	55,050,000	55,000,000	50,000
1858	50,500,000	50,000,000	500,000
1859	50,100,000	50,000,000	100,000
1860	46,150,000	46,000,000	150,000
1861	45,000,000	43,000,000	2,000,000
1862	43,700,000	39,200,000	4,500,000
1863	48,500,000	40,000,000	8,500,000
1864	57,100,000	46,100,000	11,000,000
1865	64,475,000	53,225,000	11,250,000
1866	63,500,000	53,500,000	10,000,000
1867	65,225,000	51,725,000	13,500,000
1868	60,000,000	48,000,000	12,000,000
1869	61,500,000	49,500,000	12,000,000
1870	66,000,000	50,000,000	16,000,000
1871	66,5-0,000	43,500,000	23,000,000
1872	64,750,000	36,000,000	28,750,000
1873	71,750,000	36,000,000	35,750,000
1874	70,800,000	33,500,000	37,300,000
1875	65,100,000	33,400,000	31,700,000
1876	78,700,000	39,900,000	38,800,000
1877	86,700,000	46,900,000	39,800,000
1878	96,400,000	51,200,000	45,200,000
1879	79,700,000	38,900,000	40,800,000
1880	75,200,000	36,000,000	39,200,000
1881	77,700,000	34,700,000	43,000,000
1882	79,300,000	32,500,000	46,800,000
1883	76,200,000	30,000,000	46,200,000
1884	79,600,000	30,800,000	48,800,000
1885	83,400,000	31,800,000	51,600,000
1886	86,000,000	35,000,000	51,000,000
1887	86,350,000	33,000,000	53,350,000
1888	92,370,000	35,175,000	59,195,000
1889 { mint	97,446,000	32,800,000	64,646,000
1889 { census	99,282,896	32,886,180	66,396,688
1890	103,230,714	32,845,000	70,485,714
1891	108,591,565	33,175,000	75,416,565
1892	107,989,900	33,000,000	74,989,900
Total	3,086,064,948	1,937,881,769	1,148,183,179

a Insignificant.

In the tables below the product is distributed, as well as possible, among the States where it was produced.

Distribution of the gold and silver product of 1892, by States.

[Estimated by the Director of the Mint.]

States and Territories.	Gold.		Silver.		Total value.
	Fine ounces.	Value.	Fine ounces.	Coining value.	
Alaska	48,375	$1,000,000	8,000	$10,343	$1,010,343
Arizona	51,761	1,070,000	1,062,220	1,373,375	2,443,375
California	580,500	12,000,000	360,400	465,455	12,465,455
Colorado	256,387	5,300,000	24,000,000	31,030,303	36,330,303
Georgia	4,583	94,734	400	517	95,251
Idaho	83,271	1,721,364	3,164,269	4,091,176	5,812,540
Michigan	3,386	70,000	60,000	77,576	147,576
Montana	139,871	2,891,386	17,350,000	22,432,329	25,323,709
Nevada	76,021	1,571,500	2,244,000	2,901,333	4,472,833
New Mexico	45,956	950,000	1,075,000	1,389,899	2,339,899
North Carolina	3,800	78,560	9,000	11,636	90,196
Oregon	67,725	1,400,000	50,000	64,646	1,464,646
South Carolina	5,986	123,765	400	517	123,882
South Dakota	178,987	3,700,000	60,000	77,576	3,777,576
Texas	.....	.....	380,000	490,808	490,808
Utah	31,936	660,175	8,100,000	10,472,727	11,132,902
Washington	18,071	373,564	150,000	193,939	567,500
Other States *a*	500	10,336	1,000	1,293	11,629
Total	1,597,098	33,014,081	58,004,289	74,895,442	108,010,423

a Includes Alabama, Maryland, Tennessee, Vermont, Virginia, and Wyoming.

Approximate distribution in round numbers, by States and Territories, of the estimated total product of precious metals in the United States during the calendar years 1881 to 1892, inclusive.

States and Territories.	1881.			1882.		
	Gold.	Silver.	Total.	Gold.	Silver.	Total.
Alaska	$15,000	.....	$15,000	$150,000	.....	$150,000
Arizona	1,065,000	$7,300,000	8,360,000	1,065,000	$7,500,000	8,565,000
California	18,200,000	750,000	18,950,000	16,800,000	845,000	17,645,000
Colorado	3,300,000	17,100,000	20,400,000	3,360,000	16,500,000	19,860,000
Dakota	4,000,000	70,000	4,070,000	3,300,000	175,000	3,475,000
Georgia	125,000	.....	125,000	250,000	.....	250,000
Idaho	1,700,000	1,300,000	3,000,000	1,500,000	2,000,000	3,500,000
Maine	.....	5,000	5,000	.....	.....	.....
Montana	2,350,000	2,650,000	4,960,000	2,550,000	4,370,000	6,920,000
Nevada	2,250,000	7,080,000	9,330,000	2,000,000	6,750,000	8,750,000
New Mexico	185,000	275,000	460,000	150,000	1,800,000	1,950,000
North Carolina	115,000	.....	115,000	190,000	25,000	215,000
Oregon	1,100,000	50,000	1,150,000	830,000	35,000	865,000
South Carolina	35,000	.....	35,000	25,000	.....	25,000
Tennessee	5,000	.....	5,000	.....	.....	.....
Utah	145,000	6,400,000	6,545,000	190,000	6,800,000	6,990,000
Virginia	10,000	.....	10,000	15,000	.....	15,000
Washington	120,000	.....	120,000	120,000	.....	120,000
Wyoming	5,000	.....	5,000	5,000	.....	5,000
Total	34,700,000	43,000,000	77,700,000	36,500,000	46,800,000	79,300,000

	1883.			1884.		
Alaska	$300,000	.....	$300,000	$200,000	.....	$200,000
Arizona	950,000	$5,200,000	6,150,000	930,000	$4,500,000	5,430,000
California	14,125,000	1,460,000	15,580,000	13,600,000	3,000,000	16,600,000
Colorado	4,100,000	17,370,000	21,470,000	4,250,000	16,000,000	20,250,000
Dakota	3,200,000	150,000	3,350,000	3,300,000	150,000	3,450,000
Georgia	100,000	1,000	200,000	157,000	.....	157,000
Idaho	1,400,000	2,100,000	3,500,000	1,250,000	2,720,000	3,970,000
Montana	1,800,000	6,000,000	7,800,000	2,170,000	7,000,000	9,170,000
Nevada	2,520,000	5,430,000	7,950,000	3,500,000	5,600,000	9,100,000
New Mexico	280,000	2,845,000	3,125,000	300,000	3,000,000	3,300,000
North Carolina	167,000	3,000	170,000	157,000	3,500	160,500
Oregon	660,000	20,000	680,000	660,000	20,000	680,000
South Carolina	56,500	500	57,000	57,000	500	57,500
Utah	140,000	5,620,000	5,760,000	120,000	6,800,000	6,920,000
Virginia	6,000	.....	6,000	2,000	.....	2,000
Washington	80,500	500	80,500	85,000	1,000	86,000
Wyoming	4,000	.....	4,000	6,000	.....	6,000
Other	17,500	.....	17,500	76,000	5,000	81,000
Total	30,000,000	46,200,000	76,200,000	30,800,000	48,800,000	79,600,000

	1885.			1886.		
Alaska	$300,000	$2,000	$302,000	$446,000	$2,000	$448,000
Arizona	880,000	3,800,000	4,680,000	1,110,000	3,400,000	4,510,000
California	12,700,000	3,500,000	15,200,000	14,725,000	1,400,000	16,125,000
Colorado	4,250,000	15,800,000	20,050,000	4,450,000	16,000,000	20,450,000
Dakota	3,200,000	100,000	3,300,000	2,700,000	425,000	3,125,000
Georgia	136,000	.....	136,000	152,500	1,000	153,500
Idaho	1,800,000	3,500,000	5,300,000	1,800,000	3,600,000	5,400,000
Montana	3,300,000	10,000,000	13,300,000	4,425,000	12,400,000	16,825,000
Nevada	3,100,000	6,000,000	9,100,000	3,090,000	5,000,000	8,090,000
New Mexico	800,000	3,000,000	3,800,000	400,000	2,300,000	2,700,000
North Carolina	152,000	3,000	155,000	175,000	3,000	178,000
Oregon	800,000	10,000	810,000	990,000	5,000	995,000
South Carolina	43,000	.....	43,000	37,500	500	38,000
Utah	180,000	6,750,000	6,930,000	216,000	6,500,000	6,716,000
Washington	120,000	70,000	190,000	147,000	80,000	227,000
Texas, Alabama, Tennessee, Virginia, Vermont, Michigan, and Wyoming	90,000	5,000	95,000	5,000	205,000	210,000
Total	31,801,000	51,600,000	83,401,000	34,869,000	51,321,500	86,190,500

Approximate distribution in round numbers, by States and Territories, of the estimated total product of precious metals in the United States, etc.—Continued.

States and Territories.	1887.			1888.		
	Gold.	Silver.	Total.	Gold.	Silver.	Total.
Alaska	$675,000	$300	$675,300	$850,000	$3,000	$853,000
Arizona	830,000	3,800,000	4,630,000	871,500	3,000,000	3,871,500
California	13,400,000	1,500,000	14,900,000	12,750,000	1,400,000	14,150,000
Colorado	4,000,000	15,000,000	19,000,000	3,758,000	19,000,000	22,758,000
Dakota	2,400,000	40,000	2,440,000	2,600,000	100,000	2,700,000
Georgia	110,000	500	110,500	104,000	500	104,500
Idaho	1,900,000	3,000,000	4,900,000	2,400,000	3,000,000	5,400,000
Michigan	35,000	26,000	61,000	42,000	84,000	126,000
Montana	5,230,000	15,500,000	20,730,000	4,200,000	17,000,000	21,200,000
Nevada	2,500,000	4,900,000	7,400,000	2,525,000	7,000,000	10,525,000
New Mexico	500,000	2,300,000	2,800,000	602,000	1,200,000	1,802,000
North Carolina	225,000	5,000	230,000	136,000	3,500	139,500
Oregon	900,000	10,000	910,000	825,000	15,000	840,000
South Carolina	50,000	500	50,500	39,000	200	39,200
Utah	220,000	7,000,000	7,220,000	290,000	7,000,000	7,290,000
Washington	150,000	100,000	250,000	145,000	100,000	245,000
Texas	.....	250,000	250,000	.....	300,000	300,000
Alabama, Tennessee, Virginia, Vermont, Michigan, and Wyoming	22,000	1,000	23,000	30,000	500	30,500
Total	33,147,000	53,433,300	86,580,300	33,167,500	59,206,700	92,374,200

	1889.			1890.		
Alaska	$900,000	$10,343	$910,343	$762,500	$9,697	$772,197
Arizona	900,000	1,939,393	2,839,393	1,000,000	1,292,929	2,292,929
California	13,000,000	1,034,343	14,034,343	12,500,000	1,163,636	13,663,636
Colorado	4,000,000	20,686,868	24,186,868	4,150,000	24,307,070	28,457,070
Dakota	2,900,000	64,646	2,964,646	3,200,000	129,292	3,329,292
Georgia	107,000	465	107,465	100,000	517	100,517
Idaho	2,000,000	4,395,959	6,395,959	1,850,000	4,783,838	6,633,838
Michigan	70,000	77,575	147,575	90,000	71,111	161,111
Montana	3,500,000	19,393,939	22,893,939	3,300,000	20,363,636	23,663,636
Nevada	5,000,000	6,206,060	9,206,060	2,800,000	5,753,535	8,553,535
New Mexico	1,000,000	1,461,010	2,461,010	850,000	1,630,808	2,580,808
North Carolina	145,000	3,878	148,878	118,500	7,757	126,257
Oregon	1,200,000	38,787	1,238,787	1,100,000	96,969	1,196,969
South Carolina	45,000	232	45,232	100,000	517	100,517
Utah	500,000	9,050,505	9,550,505	680,000	10,343,434	11,023,434
Washington	175,000	103,434	278,434	204,000	90,505	294,505
Texas	.....	300,000	300,000	.....	387,878	387,878
Alabama, Tennessee, Virginia, Vermont, and Wyoming	25,000	1,293	26,293	40,000	2,585	42,585
Total	32,967,000	64,768,730	97,735,730	32,845,000	70,485,714	103,330,714

	1891.			1892.		
Alaska	$900,000	$10,343	$910,343	$1,000,000	$10,343	$1,010,343
Arizona	975,000	1,913,535	2,888,535	1,070,000	1,373,375	2,443,375
California	12,600,000	969,697	13,569,697	12,000,000	465,455	12,465,455
Colorado	4,600,000	27,358,384	31,958,384	5,700,000	31,030,303	36,730,303
South Dakota	3,550,000	129,293	3,679,293	94,734	517	95,251
Georgia	80,000	517	80,517	1,721,364	4,091,176	5,812,540
Idaho	1,600,000	5,216,970	6,816,970	70,000	77,576	147,576
Michigan	75,000	94,384	169,384	2,891,386	22,432,323	25,323,709
Montana	2,800,000	21,170,394	24,029,394	1,571,500	2,901,333	4,472,833
Nevada	2,050,000	4,551,111	6,601,111	950,000	1,389,899	2,339,899
New Mexico	90,000	1,713,131	2,618,131	78,560	11,636	90,196
North Carolina	95,000	6,465	101,465	1,400,000	64,646	1,464,646
Oregon	1,640,000	297,374	1,937,374	123,365	517	123,882
South Carolina	125,000	646	125,646	3,700,000	76	3,777,576
Utah	650,000	11,313,131	11,963,131	400,000	808	400,808
Washington	335,000	213,334	548,334	660,175	527	11,132,902
Texas	.....	484,848	484,848	573,561	939	567,500
Alabama, Tennessee, Virginia, Vermont, and Wyoming	25,000	4,008	29,008	10,390	1,293	11,629
Total	33,175,000	75,416,565	108,591,565	33,014,435	105,442	108,010,423

Rank of the States and Territories in the production of gold and silver.

1886.

Rank.	Gold.	Rank.	Silver.	Rank.	Total.
1	California.	1	Colorado.	1	Colorado.
2	Colorado.	2	Montana.	2	Montana.
3	Montana.	3	Utah.	3	California.
4	Nevada.	4	Nevada.	4	Nevada.
5	Dakota.	5	Idaho.	5	Utah.
6	Idaho.	6	Arizona.	6	Idaho.
7	Arizona.	7	New Mexico.	7	Arizona.
8	Oregon.	8	California.	8	Dakota.
9	Alaska.	9	Dakota.	9	New Mexico.
10	New Mexico.	10	"Other."	10	Oregon.
11	Utah.	11	Washington.	11	Alaska.
12	North Carolina.	12	Oregon.	12	Washington.
13	Georgia.	13	North Carolina.	13	"Other."
14	Washington.	14	Alaska.	14	North Carolina.
15	South Carolina.	15	Georgia.	15	Georgia.
16	"Other."	16	South Carolina.	16	South Carolina.

1887.

1	California.	1	Montana.	1	Montana.
2	Montana.	2	Colorado.	2	Colorado.
3	Colorado.	3	Utah.	3	California.
4	Nevada.	4	Nevada.	4	Nevada.
5	Dakota.	5	Arizona.	5	Utah.
6	Idaho.	6	Idaho.	6	Idaho.
7	Oregon.	7	New Mexico.	7	Arizona.
8	Arizona.	8	California.	8	New Mexico.
9	Alaska.	9	Texas.	9	Dakota.
10	New Mexico.	10	Washington.	10	Oregon.
11	North Carolina.	11	"Other."	11	Alaska.
12	Utah.	12	Dakota.	12	Washington.
13	Washington.	13	Michigan.	13	Texas.
14	Georgia.	14	Oregon.	14	North Carolina.
15	South Carolina.	15	North Carolina.	15	Georgia.
16	Michigan.	16	Georgia.	16	"Other."
17	"Other."	17	South Carolina.	17	South Carolina.
		18	Alaska.	18	Michigan.

1888.

1	California.	1	Colorado.	1	Colorado.
2	Montana.	2	Montana.	2	Montana.
3	Colorado.	3	Nevada.	3	California.
4	Nevada.		Utah.	4	Nevada.
5	Dakota.	4	Arizona.	5	Utah.
6	Idaho.		Idaho.	6	Idaho.
7	Arizona.	5	California.	7	Arizona.
8	Alaska.	6	New Mexico.	8	Dakota.
9	Oregon.	7	Texas.	9	New Mexico.
10	New Mexico.	8	Dakota.	10	Alaska.
11	Utah.		Washington.	11	Oregon.
12	Washington.	9	Michigan.	12	Texas.
13	North Carolina.	10	Oregon.	13	Washington.
14	Georgia.	11	North Carolina.	14	North Carolina.
15	Michigan.	12	Alaska.	15	Michigan.
16	South Carolina.	13	Georgia.	16	Georgia.
17	"Other."		"Other."	17	South Carolina.
		14	South Carolina.	18	"Other."

Rank of the States and Territories in the production of gold and silver— Continued.

1889.

Rank.	Gold.	Rank.	Silver.	Rank.	Total.
1	California.	1	Colorado.	1	Colorado.
2	Colorado.	2	Montana.	2	Montana.
	Montana.	3	Utah.	3	California.
3	Nevada.	4	Nevada.	4	Utah.
4	Dakota.	5	Idaho.	5	Nevada.
5	Idaho.	6	Arizona.	6	Idaho.
6	Oregon.	7	New Mexico.	7	Dakota.
7	New Mexico.	8	California.	8	Arizona.
8	Alaska. Arizona.	9	Texas.	9	New Mexico.
9	Utah.	10	Washington.	10	Oregon.
10	Washington.	11	Michigan.	11	Alaska.
11	North Carolina.	12	Dakota.	12	Texas.
12	Georgia.	13	Oregon.	13	Washington.
13	Michigan.	14	Alaska.	14	North Carliona.
14	South Carolina.	15	North Carolina.	15	Michigan.
15	"Other."	16	"Other."	16	Georgia.
		17	Georgia.	17	South Carliona.
		18	South Carolina.	18	"Other."

1890.

1	California.	1	Colorado.	1	Colorado.
2	Colorado.	2	Montana.	2	Montana.
3	Montana.	3	Utah.	3	California.
4	Dakota.	4	Nevada.	4	Utah.
5	Nevada.	5	Idaho.	5	Nevada.
6	Idaho.	6	New Mexico.	6	Idaho.
7	Oregon.	7	Arizona.	7	Dakota.
8	Arizona.	8	California.	8	New Mexico.
9	New Mexico.	9	Texas.	9	Arizona.
10	Alaska.	10	Dakota.	10	Oregon.
11	Utah.	11	Oregon.	11	Alaska.
12	Washington.	12	Washington.	12	Texas.
13	North Carolina.	13	Michigan.	13	Washington.
14	South Carolina. Georgia.	14	Alaska.	14	Michigan.
15	Michigan.	15	North Carolina.	15	North Carliona.
16	"Other."	16	"Other."	16	Georgia.
		17	Georgia. South Carolina.	17	South Carolina. "Other."

1891.

1	California.	1	Colorado.	1	Colorado.
2	Colorado.	2	Montana.	2	Montana.
3	South Dakota.	3	Utah.	3	California.
4	Montana.	4	Idaho.	4	Utah.
5	Nevada.	5	Nevada.	5	Idaho.
6	Idaho.	6	Arizona.	6	Nevada.
7	Oregon.	7	New Mexico.	7	South Dakota.
8	Arizona.	8	California.	8	Arizona.
9	New Mexico.	9	Texas.	9	New Mexico.
10	Alaska.	10	Oregon.	10	Oregon.
11	Utah.	11	Washington.	11	Alaska.
12	Washington.	12	South Dakota.	12	Washington.
13	South Carolina.	13	Michigan.	13	Texas.
14	North Carolina.	14	Alaska.	14	Michigan.
15	Georgia.	15	North Carolina.	15	South Carolina.
16	Michigan.	16	"Other."	16	North Carolina.
17	"Other."	17	South Carolina.	17	Georgia.
		18	Georgia.	18	"Other."

Rank of the States and Territories in the production of gold and silver— Continued.

1892.

Rank.	Gold.	Rank.	Silver.	Rank.	Total.
1	California.	1	Colorado.	1	Colorado.
2	Colorado.	2	Montana.	2	Montana.
3	South Dakota.	3	Utah.	3	California.
4	Montana.	4	Idaho.	4	Utah.
5	Idaho.	5	Nevada.	5	Idaho.
6	Nevada.	6	New Mexico.	6	Nevada.
7	Oregon.	7	Arizona.	7	South Dakota.
8	Arizona.	8	California.	8	Arizona.
9	Alaska.	9	Texas.	9	New Mexico.
10	New Mexico.	10	Washington.	10	Oregon.
11	Utah.	11	South Dakota.	11	Alaska
12	Washington.	12	Michigan.	12	Washington.
13	South Carolina.	13	Oregon.	13	Texas.
14	Georgia.	14	North Carolina.	14	Michigan.
15	North Carolina.	15	Alaska.	15	South Carolina.
16	Michigan.	16	Georgia.	16	Georgia.
		17	South Carolina.	17	North Carolina.

ALASKA.

The general trend of the mountain systems of the west coast of our continent runs more to the west of north than does that of the coast line itself; hence, from Washington northward through British Columbia to southern Alaska, an ever-increasing portion of these mountains have in part run out into the ocean, and form the remarkably continuous chain of islands which lend so much scenic beauty to the Alaskan coast. What little is known of their geological history points to a considerable analogy with that of the western slope of the Sierra Nevada, viz., an uplift in post-Jurassic or early Cretaceous times, followed by a deposition, in comparatively shallow waters, of later Cretaceous and Tertiary beds, with local development of important coals and frequent exhibitions of eruptive energy continued down to comparatively recent geological time.

As to the Alaskan peninsula proper, beyond Mount Saint Elias, where the coast line takes a trend due west and then southwest, still less is known geologically, for explorations have been confined to the immediate banks of the Yukon river, which is either so far north or so far in the interior as to be beyond the beneficent influence of the Japanese gulf stream, which alone renders the immediate coast line of southern Alaska inhabitable during the colder part of the year. It is known that the coal-bearing Laramie rocks extend far northward toward the Arctic circle in the interior, and that the cross chain of the Aleutian islands, which extends southwestward from the point of the peninsula, is eruptive and probably of recent origin; but while it may be considered probable that geological representatives of the older rocks, which form the mountain chains further south, extend into the peninsula, the determination of this fact is not of much evident importance to the mining industry, since climatic conditions would appear to be such as to preclude extended mining operations there. It is the

island belt and the immediate shores of the mainland in southern Alaska, with its comparatively mild climate and easy water transportation over inclosed waters, that offer the best opportunities for the systematic development of the mineral wealth that geological conditions show must exist in the region. The development of this wealth may be said to have commenced with the decade, and the first steps were taken by the placer miners with their gold pans, washing the sands of the streams and the débris from the hillsides. They did not confine themselves in their explorations to the coast belt, but crossed the mountains to the waters flowing into the Yukon river. Here gravels rich enough to pay under primitive methods have been found, and from the Yukon district, on Forty-mile creek, over a quarter of a million dollars worth of gold is said to have been obtained without the use of mercury. It is quite impossible to determine with any accuracy the amount of gold actually produced by such workings, on account of the number of individual miners who carry away and sell the gold dust they obtain; hence, the figures given below may be taken as considerably below the actual amount extracted. It seems doubtful, however, whether this interior country, where, owing to the severity of the climate, it is possible to work less than a third of the year, and the expense of transporting supplies over the mountains is very great, will ever become the scene of systematic mining.

In the coast belt, however, explorations consequent upon placer mining have already led to vein mining. One important mine, the Treadwell, upon Douglass island, in latitude 58°, produces, however, two-thirds of the estimated output of the Territory. It is a quartz vein 400 feet in width, carrying free gold and auriferous pyrites, which outcrops on a steep hillside running down to the sea shore. The ore is of such very low grade that were it not for the peculiarly advantageous situation of the mine, which reduces cost to a minimum, it could hardly be worked at a profit. As it is, however, good management and an intelligent expenditure of capital have developed a large paying mine, which has produced during the past four years an annual average of nearly three-quarters of a million of gold and has had a most beneficial effect in stimulating systematic mining in the region. The mineral belt as thus far developed has a longitudinal extent of about 100 miles in a northwestern and southeastern direction, but is said to be only a few miles wide, and, even should it prove to be geologically wider, climatic conditions will probably confine the area of profitable working to the immediate proximity of the ocean. The general geological conditions that prevail in this belt, as far as known, show a close resemblance to the gold belt of California; like the latter the values are principally in gold, which is accompanied in certain parts of the region by silver, galena, and copper ores. It is probable, however, that in this colder region the limit in depth of free gold or oxidized ores will be sooner reached, and the miner be brought to face the problem of

profitably treating auriferous sulphurets, which has so often proved an insurmountable obstacle to the continued development of gold mines. This obstacle has, however, already been successfully overcome in the Treadwell mine by the adaptation of the chlorination process.

The annual product of the Territory, which is given as exclusively gold (the silver product being comparatively insignificant) shows a steady increase during the decade. This increase is remarkable rather for its regularity than its amount and is hence of more favorable import for the permanency of the development of the mineral resources than would be one subject to violent fluctuations, for while the discovery of exceptionally rich ore bodies undoubtedly causes a rapid development of the district in which they occur, the reaction which follows the inevitable exhaustion of such bodies may more than counteract the good effect which they have had, so far as its permanent prosperity is concerned.

Production of gold in Alaska since 1880.

Years.	Value.	Years.	Value.
1880	$5,951	1887	$675,000
1881	15,000	1888	850,000
1882	150,000	1889	900,000
1883	300,000	1890	762,000
1884	200,000	1891	900,000
1885	300,000	1892	1,000,000
1886	446,000		

ARIZONA.

But little is known with certainty about the geological relations of the ore deposits of Arizona, no systematic geological studies yet having been made of the Territory as a whole, nor of any of its rich mining districts. As its name indicates it is a generally arid region, the aridity increasing from the east, westward and southward, the western part of the Territory, though traversed by the Colorado river, having the desert features that characterize the greater part of Nevada.

The northeastern portion forms part of the Colorado plateau, about one-third of which is included within the boundaries of Arizona. It is an elevated region supporting some forest growth, and as contrasted with the rest of the Territory is fairly well watered. To the southwest of the plateau region are a series of narrow isolated ranges separated by broad arid valleys, similar to the basin ranges of Nevada, with which, by their general northwesterly trend, they are connected. They are made up generally of Paleozoic strata resting on a basement of crystalline rocks, and traversed to a greater or less extent by eruptives. The intervening valleys in general increase in width to the southwest, approach more and more to sea level, and Paleozoic strata disappear, the rocks being mainly granites and schists. Coal-bearing rocks appear to be entirely wanting. Under such physical conditions mining and pastoral pursuits are the only self-supporting industries. Two transcontinental railway lines cross the Territory from east to west, but have few branches, the greater part of the region not being able to support anything more than the sparsest population.

Detrital material is accumulated in very considerable quantities in some of the valleys, especially in the central part of the Territory. Many of them contain considerable amounts of free gold, but the scarcity of water in most cases forms an insurmountable obstacle to their development. Some attempts are said to have been made to utilize the water of the Colorado river in working neighboring placer gravels, but with what success is not reported.

The product of the Territory may be, therefore, assumed to come almost exclusively from deep mines. The statistics of production show a fairly steady annual output of gold amounting to about a million of dollars in value, while the product of silver has decreased with remarkable regularity from over seven millions at the beginning of the decade to about a million and a quarter at its close. The most important silver-producing region has been the Tombstone district, in the southeastern part of the Territory, where silver-lead deposits in limestone, associated with eruptive rocks, commenced producing early in the decade. The product of the county (Cochise) in which these mines occur is said in 1882 to have been as much as $600,000 in gold and over $5,000,000 in silver, and in 1892 to have fallen off to about a tenth of these amounts, respectively.

Silver-lead deposits have been developed in other parts of the Territory to a certain extent, and do not appear to have been entirely confined to limestones, which may account for their relatively small and uncertain production, for it is in these rocks that the immense bodies of lead and silver ores yielding annual products of several millions in value are usually found.

Arizona undoubtedly possesses great mineral wealth and abundant stores of precious-metal ores, but in the absence of any definite geological knowledge with regard to them it is impossible to intelligently account for the decrease in the product. Probably the want of such knowledge has been a factor in this decrease, since capital is with difficulty induced to invest in the unknown. Other probable causes are to be found in the physical character of the region, a want of abundant and cheap transportation facilities, and the absence of local supplies of coal, all of which render the cost of mining and of reduction of the ores relatively high, so that only exceptionally rich ores yield a profit to the miner, and such ores are generally in small amount and rapidly exhausted. An abundant supply of low-grade ores is the surest basis on which a permanent mining industry can be found. With a falling price of silver the outlook for precious-metal production in the Territory must therefore be considered most unpromising, for successful gold mining is, as a rule, even more dependent on low costs than silver mining.

Production of gold and silver in Arizona, since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$211,965	$2,325,825	1887	830,000	$3,800,000
1881	1,060,000	7,700,000	1888	871,500	3,000,000
1882	1,062,000	7,500,000	1889	900,000	1,938,393
1883	950,000	5,200,050	1890	1,000,000	1,292,929
1884	930,000	4,530,000	1891	975,000	1,913,535
1885	880,000	3,800,000	1892	1,070,000	1,373,375
1886	1,110,000	3,400,000			

CALIFORNIA.

Although the yield of the gold deposits of California has from various causes greatly fallen off during the decade, this State still holds the first rank as a gold producer. The original source of the gold of California is found in the quartz veins occurring in a highly metamorphosed series of rocks, of both sedimentary and eruptive origin, steeply upturned against the west flank of the great granite bodies of the Sierra Nevada, and generally known as the gold belt or auriferous slates. By their great alteration the fossil casts of the sedimentary series have been so largely obliterated that their exact geological age has been almost impossible to determine. The first recognizable fossils found in them were considered to be of Jurassic age, but more detailed studies of later years have extended the possible age of the gold-bearing sedimentary rocks downward into the Paleozoic and upward into the Lower Cretaceous. The eruptive rocks are intrusive diorites and diabases, in some cases altered into serpentine. Resting unconformably upon the auriferous slates along the foothills are beds of later Cretaceous age which contain no original deposits of gold.

For something over 100 miles northward from what was originally considered as the southern limit of the gold belt proper, the quartz veins follow the apparent strike of the slates in a north and south direction, parallel with the general trend of the range, and form a regular and definite line, which is known as the Mother lode. These veins are generally in the sedimentary rocks, sometimes at the contact of intrusive bodies. Their principal metallic constituents are free gold and auriferous pyrites, with insignificant amounts of other metals. The above-mentioned characteristics hold good for a majority of the veins in the gold belt, but there are many variations from them, especially in the middle region from whose disintegration the richest placers were derived. The veins sometimes trend east and west and are entirely inclosed in eruptive rocks, in which case their mineral constituents are more varied and include some silver and base metal ores. In other cases they show a tendency to follow in the sedimentary beds a direction parallel with the contact of inclosed eruptive bodies, and again cross from the former into the latter. A certain belt of diabase is characterized by the occurrence of copper ores.

The auriferous slates were at first supposed to be confined to the Sierra Nevada proper, which terminates on the north in the geological break made by the lava flows surrounding the extinct volcanoes of Lassens peak and Mount Shasta, and at the south is cut off topographically by the Mojave desert. Their geological representatives have since been traced to the northern boundary of the State and into western Oregon, and their continuation beyond the desert is found in the mountains of southern California and extends across the boundary into Lower California along the eastern side of the peninsula.

It was in the middle region of the western slope of the Sierra Nevada that the original discovery of placer deposits was made, and this region has since continued to be the greatest producer of gold. Here the topographical conditions were peculiarly favorable to the concentration of gravel and detrital material resulting from the disintegration of gold-bearing rocks into bodies that could readily be worked by the aid of abundant water. The high range of the Sierra, with its remarkably long western slope, 50 miles in extent, condenses the moisture-laden currents coming from the Pacific into large and rapid streams, which become violent torrents during certain seasons. The great diurnal variation of temperature is moreover a powerful disintegrating agent. Under these conditions unusually large amounts of detrital matter are carried down by the modern streams, and in their long courses a very considerable concentration of the heavy sands rich in free gold takes place. These conditions must have prevailed to a considerable extent in an earlier geological period, for not only are rich gravels found along the beds of modern streams, but the beds of ancient and now abandoned rivers, crossing the modern ones at a considerable angle, are found to be filled with gold-bearing gravels. These ancient gravels have been in part protected from erosion by flows of lava, which constitute the many table mountains of the region, and in part remain as gravel ridges between the beds of the modern streams.

The rapid descent and considerable volume of the modern streams are more especially favorable to a system of mining which originated here when the richer modern placers were so far exhausted that it was no longer profitable to work them by former primitive methods. This is known as hydraulic mining, and consists in directing an artificial stream through a large nózzle and under the pressure of a high column of water upon a gravel bank and washing it bodily into sluice boxes, in which the gold is in part automatically caught by mercury properly disposed to come into contact with it. Under this system it has been possible to work over whole mountains of débris and extract at a profit the gold from gravel that contains only a few cents worth per cubic yard. Where, owing to the lava covering and the compacted nature of the gravel, this process is not practicable, drift mining has been resorted to, and tunnels have been run to reach the beds of the ancient streams and extract the richer concentration of gravel in the

hollows of these beds. All these methods, properly classed as placer mining, since they work only upon detrital material, have kept up the proportion of gold produced from placers in spite of the rapid exhaustion of the richer concentrations in the lower parts of the stream beds. In 1880, according to census returns, about half of the total gold product of the State, which was over seventeen millions of dollars, was derived from placer mines and half from deep mines or original deposits. Later returns do not segregate the product of placer from that of deep mines, but it is safe to assume that the decrease in the gold product during the decade to an average of $12,000,000 to $13,000,000 has been largely due to a decrease in hydraulic mining. The farmers had long been complaining of the damage to their arable land resulting from the sands and gravel spread out over them by hydraulic mining, and, as a result of litigation in the early part of the decade, a law was passed entirely prohibiting this form of mining on navigable streams. As a result of this the greater part of the hydraulic mining in the State was stopped, and drift mining, on account of its expense, could not adequately fill its place. Costly ditches and hydraulic plants were thereby rendered practically valueless and capital was discouraged from investing in this form of mining, which necessarily involves a very large preliminary expenditure of money before any returns can be expected. In 1892 Congress passed a law providing for the appointment of a commission under whose supervision impounding dams and other means of taking care of the débris might be constructed, which it was expected would result in the resumption of work by a considerable portion of existing hydraulic mines. The statistics of production have not yet shown any beneficial result from this action, which, however, would necessarily be slow on account of the well-known timidity of capital in regard to mining enterprises, especially where any permanent effects of legislation must be depended upon. It may reasonably be looked for in time, however, when confidence in the efficiency of this measure is created, and especially as a result of the fall in the price of silver, which will naturally direct investments into gold rather than silver mining. Deep or vein mining has apparently been fairly permanent in its production. Where one mine runs out of good ore another runs into it. The increase in expense as the mine grows deeper is more or less offset in reduction in cost of treatment, as mechanical and chemical processes of concentration result in the extraction of an increasing percentage of the gold contained, especially in sulphuret ores.

In those portions of the gold belt beyond the immediate slopes of the Sierra Nevada, both north and south, topographical conditions have not been, as a rule, so favorable to the formation of large areas of placer ground. This incentive to the rapid development of a gold region being wanting, the progress of gold mining has necessarily been slow, although it is known that valuable gold ores exist in the rocks. A commencement has been made, however, and when existing mines have

proved themselves successful others will be opened. The advance will undoubtedly be more rapid when systematic surveys are completed which shall give authoritative information as to the existing geological conditions.

The silver product of the State of California, as shown by the table below, is small and very variable. A portion of it is produced in the gold belt proper as a by-product in gold-mining and in part as an actual alloy with the gold. The greater portion produced during the decade has, however, been derived from Mono, Inyo, and San Bernardino counties, in the eastern part of the State, from deposits whose geological relations ally them rather with Nevada or Great Basin methods of occurrence than with those of California. They consist of rich silver minerals occurring in recent eruptives or in limestones, and are confined to a comparatively few localities. Unless some such great vein as the Comstock should be discovered, which is hardly likely, it is not probable that the silver output of California in the immediate future will be considerable or permanent. In that of gold, however, it is reasonable to look for a steady and permanent, though perhaps not very rapid, increase.

Production of gold and silver in California since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$17,150,241	$1,150,887	1887	$13,400,000	$1,500,000
1881	18,200,000	750,000	1888	12,750,000	1,400,000
1882	16,800,000	845,030	1889	13,000,000	1,454,343
1883	14,120,000	1,400,000	1890	12,500,000	1,163,636
1884	13,600,000	3,500,000	1891	12,000,000	969,697
1885	12,700,000	2,500,000	1892	12,000,000	465,455
1886	14,725,000	1,400,000			

COLORADO.

Colorado is a region exceptionally well adapted, both physically and geologically, to become the scene of a great and permanent mining industry. The great mass and elevation of its mountains produce a relatively abundant precipitation, and the waters of its numerous mountain streams furnish the means for rendering a large portion of its valley and plain area rich agricultural regions capable of supporting a considerable population. Extensive and valuable coals are found in almost every portion of the State, and railroads have sent their ramifications in every direction, not only through the valleys, but over the tops of high mountain ranges, wherever there was promise of the founding of a permanent industry.

The geological structure of its numerous high mountain ranges, showing, as it does, the results of repeated and powerful orographic movements accompanied by plentiful outbursts of eruptive rocks, indicates conditions peculiarly favorable to the concentration of metallic minerals into ore deposits. Its mineral resources are varied and abundant, and by no means confined to the precious metals; yet in the thirty-

three years that have elapsed since their discovery it has produced about one hundred and five millions of gold and three hundred millions of silver. In contrast to that of California, the development of its mining industry has been comparatively slow, and of the above-mentioned amounts nearly one-half the gold and five-sixths of the silver has been produced in the last thirteen years.

As in other regions, it was the discovery of placer gold that first attracted the miner—in 1859–'60—to what was then a comparatively unknown region. As to what was the annual product of these early years estimates vary widely and nothing is certainly known. The vein mining, which followed the exhaustion of the richer placers, was conducted under a disadvantage, for most of the ores contained a great many other metallic minerals besides gold and silver—hence constituting what is called base metal ores—and could not be reduced by the simpler process of amalgamation.

It is in the older crystalline and eruptive rocks which were the first to be prospected that the gold-bearing ores are mainly found, whereas the great bonanzas of silver-bearing ores have been found in Paleozoic limestones, and it was not until the discovery of the latter ores at Leadville in 1878–'79 that their value was recognized and prospectors paid more attention to their surface indications, which before had been considered valueless.

Smelting plants were necessary for the reduction of these ores, and it is their great increase that has been the most important factor in the rapid increase in the mining industry of Colorado since 1880. To those established in the immediate vicinity of the mines have been added great central plants at Denver and Pueblo as well as in Eastern cities, which, owing to their proximity to coal fields and to their ability to receive ores by rail from every part of the State, and even from other States, can work more cheaply and to greater advantage. The cost of smelting has thus been reduced as much as 50 per cent. during the decade. This has reacted favorably on the development of mines, since by the ready market thus afforded for their product a great many mines have been opened and worked the ores of which could not otherwise have been reduced at a profit. The effect of this industrial development has been most marked in the silver product, since the greater part of the silver ores must be reduced by smelting, whereas gold ores are more generally treated by amalgamation. The effect upon the production of gold has also been beneficial, since there are ores carrying gold, such as the telluride ores of Boulder county and the concentrates from the tailings of gold mills, from which the gold can only be extracted at a profit by mixing with other ores in the larger smelting works. Of late years, moreover, numerous wet processes for the extraction of gold from complicated ores have been successfully introduced in various parts of the State.

In considering the geological distribution of the precious-metal

bearing ores the following broad general features may be recognized. The mountain masses of Colorado are divided in a general way into two north and south uplifts—the Colorado or Front range, and the complex of ranges forming the Sawatch uplift—with a third uplift, the San Juan group, at the south, whose greatest extension is east and west rather than north and south.

The two first named uplifts consist of a nucleus of Archean or ancient crystalline rocks surrounded by a varying fringe of upturned Paleozoic and Mesozoic sediments, the whole cut through by dikes and intrusive sheets of eruptive rocks. The Paleozoic rocks are mostly limestones and quartzites; the Mesozoic rocks, sandstones and clay shales. Here the bulk of the silver-bearing ores are found in the Paleozoic limestones, while the crystalline rocks afford both gold and silver ores, and the Mesozoic rocks contain but few workable deposits. The precious-metal deposits are invariably found in more or less intimate association with the eruptive rocks, and in a few cases gold-bearing ores are found within the latter and also in the Mesozoic shales immediately adjoining them.

The San Juan group is made of a similar series of rocks, but differently distributed, eruptive rocks forming the greater part of the surface exposures and the sedimentary and ancient crystalline rock masses being so broken up that the nucleal structure is no longer apparent. The greater part of the precious-metal ores are found in the eruptive masses, being generally mixed ores carrying values in gold, silver, and other metals, but important deposits are found whose values are almost exclusively gold or silver. Precious-metal deposits are also found in the occasional exposures of Paleozoic limestones, and to a limited extent in the fringing Mesozoic sandstones.

In the Colorado or Front range the Paleozoic rocks which surround the Archean nucleus are mostly buried beneath the later Mesozoic sediments; consequently it is in the crystalline rocks and the associated eruptive masses that the principal precious-metal deposits have been found. The bulk of the product comes from the mining districts of Boulder, Clear Creek, and Gilpin counties. The ores of the former are rather unusual in that they consist largely of tellurides. Its product is relatively small, being less than half a million annually, and three-fourths of its value is in gold. Clear Creek produces mixed base-metal ores, less than a third of whose precious-metal values is in gold. In Gilpin county, which is the oldest mining district in the State, the ores are mainly pyrites and of the precious-metal values 80 to 90 per cent. is gold. It has produced since 1860 about fifty-four millions of the precious metals. The combined annual product of these three districts has varied from four to a little over five millions of the two metals, having reached the larger amount at the beginning and again at the end of the decade. The proportion of either metal in the total product has also varied from year to year, as it comes from a very great number of

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separate mines which have thin vertical veins, whose individual production is necessarily variable according as they are in bonanza or barren ground and with the depth and consequent increase in cost of extraction of the ore. Nevertheless, for the whole period the proportion of the metals has been about equal, and though no great increase in product of the region has been shown, the fact that costs of production have been so greatly reduced that mines formerly abandoned as unprofitable are being reopened assures a fair permanence. Since the close of the decade new discoveries of gold ore in eruptive rocks have been made in the Cripple Creek district at the southern end of the Front range, of whose geological relations little is yet definitely known. The annual product is said to have already reached over half a million, and to bid fair to increase rapidly. Under this influence the proportion that the gold product of this region bears to that of the State, which had fallen from two-thirds at the commencement of the decade to less than one-half at its close, has already increased, and may resume its old importance. The silver product of this range is of far less relative importance amounting to only about 12 per cent. of the total product of the State during the last thirteen years.

At the present day the Sawatch uplift is broken into several more or less distinct ranges, of which the present Sawatch range, made up as it is of Archean rocks, constitutes the original nucleus. A certain number of veins carrying base metal ores with values in gold as well as silver occur in these rocks, but their output has been insignificant compared with that derived from the overlying Paleozoic limestones which rest upon the outer edges of this central mass. Deposits in limestone, as a rule, yield a much greater and more rapidly developed product than those in so-called true fissure veins, not only because of their greater lateral extension, but because, as the limestones lie generally in a slightly inclined position, a greater bulk of ore is comparatively near the surface. These silver-bearing limestone deposits around the Sawatch uplift have yielded in the last thirteen years over $180,000,000, or 70 per cent. of the total silver product of the State.

The Leadville deposits in the Mosquito range on the east side of the Sawatch, which were the first discovered, have thus far proved the greatest. They have yielded, up to the commencement of this year, about $135,000,000 of silver and $4,500,000 of gold. The principal values are derived from sulphides of lead and iron and zinc and their decomposition products, in the order named. But very little gold, and that locally, is derived from the limestone deposits proper, a considerable proportion of the yield given above coming from ores extracted from the eruptive and crystalline rocks in the vicinity. It is somewhat singular that though the gold placers, discovered at this point as early as 1860, are said to have yielded $10,000,000 from a single, narrow gulch in a year or two, only one or two important gold deposits in place have thus far been found in the vicinity. It is not unlikely that more careful exploration may reveal others. Here, as in most ore deposits in limestone, the oxidized portions were much richer than the unaltered sulphides in depth. Hence, though enormous bodies of the latter have been found as exploration progressed in depth, with an ever-increasing output in bulk of ore the silver yield has steadily fallen off since the fourth year of the decade, the discovery of hitherto unopened bodies of rich oxidized ores in later years having been neutralized by the fall in the price of silver. Deep mining is relatively expensive owing to the large amount of water found, and unless some method is devised of treating the large bodies of low-grade base ores at a profit the yield of the district is likely to decrease much more with a continuation of the low price of silver, in spite of the great amount of capital invested there in smelting and hoisting plants.

The Aspen district, on the opposite slope of the Sawatch uplift, is the next important deposit of silver-bearing ores in limestone. The wealth and extent of its ore bodies were not suspected until the middle of the decade, and, even after two competing railroads had been built to it across the mountains, its production was delayed by litigation, so that it sprung suddenly from $800,000 in 1887 to $7,000,000 in 1888; its estimated yield up to 1893 already amounts to $14,000,000, which is practically all silver. In one mine, the Mollie Gibson, an ore body of unprecedented richness has been found, from which carload lots worth from $40,000 to $60,000 are not infrequently shipped. The geological structure of the region is not yet as well understood as that of Leadville; the same obstacle of excessive water in deep mines is met with; the ores, though richer, carry less lead, hence cost relatively more to smelt, and though the mine owners have shown unusual enterprise in the introduction of electricity as a motive power for mining machinery, as well as for lighting, and in introducing improved processes of reduction, the production of the district is likely to be seriously curtailed by a further drop in the price of silver.

Other valuable deposits in limestone around the Sawatch uplift have been developed, but none comparable in the extent of their ore development with the two above mentioned. The most important have been those of the Ten Mile and Red Cliff mining districts on the north slope, the product of the latter of which is about one-third to two-fifths gold, derived from deposits in Cambrian quartzites; and on the southeast and southwest slopes individual mines have found large bodies of silver-bearing lead ores. The total precious-metal product of such districts is an unimportant factor industrially as compared with that of the great concentrations of the Leadville and Aspen districts, and is much more susceptible to fluctuation from decrease in the value of the product since they do not have such large amounts of capital invested in plant that they must be worked in order to get some return from the investment.

The San Juan region as a whole has yielded in the thirteen years under consideration about 12 per cent. of the silver product of the State, and in the last few years of this period over one-quarter of the gold product. Its total product of precious metals has increased rapidly and steadily during the decade from a little over $250,000 in 1880 to $7,500,000 in 1890. The central and earliest developed portion of the San Juan is the most Alpine of all Colorado, and many of the important mines are situated high up in the mountains, at altitudes of 12,000 to 13,000 feet, so that in spite of the strength of the veins and the remarkable richness of the ores, it was not until a large amount of capital had been invested in roads, tunnels, and railroads that they could become large producers. These deposits are mostly vertical veins in eruptive rocks, and carry considerable values in gold as well as silver. Rich placers have been found also in recent years in the valleys of the streams flowing westward from these mountain masses. The gold product of the region which was only about $250,000 to $500,000 during the decade jumped to $1,250,000 for the last three years. Rich gold deposits in eruptive rocks in the eastern portion of the San Juan mountains were being worked at the commencement of the decade, but no reliable estimates were obtained as to the product of the district. It appears to have been quite small during most of the decade, but a slight increase is noted in 1892. Besides the veins in eruptive rocks silver-lead ores are found in Paleozoic limestones. The most important producers are those in the southwestern portion, around Rico, which, in the last three years, since railroad connections have been established, have contributed $3,750,000 in silver. Since the close of the decade remarkably rich deposits in eruptive rocks have been discovered in the Creede district on the eastern borders of the San Juan uplift, which is credited by the mint authorities with a product of $3,500,000 of silver in 1892, other estimates giving even a larger amount. Little is yet known of the geological relations of these deposits, but they seem to give promise of becoming important producers in the future.

While the region as a whole is without doubt very rich in mineral resources, its extremely rugged character makes the cost of mining relatively high and necessitates the investment of considerable capital in plant and transportation facilities, and unless some remarkably large concentration of deposits, comparable to those of Leadville, Aspen, or Butte, be discovered the development of the silver ores of the region will probably be seriously impeded by the fall in the price of this metal. On the other hand, the considerable portion of the deposits which carry a good part of their values in gold can probably still be worked at a profit, and of those which are exclusively gold-bearing, and which are hence less dependent on transportation facilities than mixed ores, the known deposits will be more actively developed, and new ones will probably be discovered.

The silver product of the three regions above named forms over 94 per cent. of the total product of the State, which therefore they practically regulate. In gold their proportion is smaller, being from 63 to 85 per cent. of the whole. Some of the balance is placer gold, but how much it is impossible to determine. There are many extensive and valuable placer deposits in Colorado, but relatively little attention has been given to them. In 1880 their product was only 3.77 per cent. of the gold product of the State. While they are relatively less important than those of Montana or California, their product can doubtless be very considerably increased, with a profit to the owners.

In considering the product of the entire State as given in the table below it will be seen that there has been an increase in the product of each of the precious metals during the decade, and that the rate of increase has been much higher since its close. For silver there was a decrease about the middle of the decade, due to the falling off in the Leadville product. This was replaced during the latter part of the decade by the rapid increase in Aspen's production, to which has been added since its close that of the new district of Creede, in either case, although primarily resulting from the discovery of large bodies of very rich ore, yet largely dependent upon the advent of railroads. The increase in the gold product in the last years is doubtless largely due to the product of the new Cripple Creek district, which the railroad has not yet reached. While the present decade may, therefore, see a considerable decrease in the silver product of the State, it is likely to be in a measure offset by an increase in its gold product.

Production of gold and silver in Colorado since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$3,200,000	$17,000,000	1887	$4,000,000	$15,000,000
1881	3,200,000	17,160,000	1888	3,758,000	19,000,000
1882	3,200,000	16,500,000	1889	4,000,000	20,686,868
1883	4,100,000	17,370,000	1890	4,150,000	24,507,070
1884	4,250,000	16,000,000	1891	4,600,000	27,358,384
1885	4,200,000	15,800,000	1892	5,300,000	31,030,303
1886	4,450,000	16,000,000			

DAKOTA.

The precious metal product of South Dakota is entirely derived from the isolated mountain group on its western boundary, known as the Black Hills. This group, which is in the form of an ellipse about 100 by 50 miles in dimensions, is a most interesting and typical example of the structure known in geology as a quaquaversal uplift, or one in which the strata dip away in every direction from a central nucleus. The central nucleus in this case consists of metamorphic slates and granites of Huronian age. The sedimentary strata, which rest upon and wrap around its edges like the leaves of an onion, are successively Cambrian sandstones, Carboniferous limestones, and a series of sandstones and shales of

Mesozoic age. The uppermost of the latter series is the coal-bearing Laramie Cretaceous.

The precious metal product is derived from the older rocks, which are, in places, cut by dikes and intrusive bodies of later eruptives. Although, as is generally the case, it was the placer gold that first attracted miners to the region in 1875, these deposits are not very extensive, and the gold derived from them forms an inconsiderable portion of the gold product of the State, having averaged in round numbers about $50,000 in the early part of the decade and $30,000 per annum in the last few years, or less than one-twentieth of the total gold product.

It is deep mining in large and easily-worked bodies of extremely low-grade ore that has been the characteristic feature of the mining industry of the region, and has placed it on an unusually permanent basis. Four large mines, now controlled by a single company, have in the last eight years contributed more than $20,000,000, or over five-sixths of the total of about $24,000,000 of gold produced in the region. Their deposits occur in the crystalline schists at the northern end of the range, in immense bodies sometimes 400 feet wide. The ore is a free milling gold ore, easily crushed, and practically free from other metallic combinations except a small amount of iron pyrite, so that, though its average yield is said to be from $2 to $4 per ton, owing to the large quantity treated, it can be worked at a profit, and the mines have paid about six million dollars in dividends to their owners. Although no ore bodies are inexhaustible and one mine of the group has already ceased producing, so that the product from these mines will necessarily decrease in time, they have proved unusually permanent and the industry established by them has encouraged the building of railroads, which furnish fuel and other necessary facilities for cheap mining; hence it is reasonable to expect that the development of other bodies will gradually replace the falling off in their product. Four competing railroads now reach the region, where none existed at the commencement of the decade.

Gold-bearing ores also occur in the Potsdam or Cambrian sandstone. The most interesting, from a scientific point of view, are the cement or conglomerate ores at its base, which are considered to be old placers formed on the shores of the Cambrian ocean from the disintegration of the rocks of the original Huronian island, but since hardened, so that the ore is crushed and milled, and its product is classed with that of deep mines. Complicated base-metal ores, rich in gold, also occur in these sandstones, and at the end of the decade had begun to be mined on a considerable scale, the more complicated smelting or lixiviation processes necessary for the treatment of such ores having been rendered practicable by the supply of cheap fuel brought in by the railroads.

Of the silver product of the State a small but regular amount is derived from the gold bullion of the gold belt mines, about 1½ per cent.

of whose value is in silver. Besides the base metal mines which contain silver as well as gold, argentiferous galena ores are also found in the Potsdam sandstone, but the main silver product has been derived from contact deposits in the Carboniferous limestones in association with eruptive rocks, and it is to variations in the productiveness of these mines probably that the fluctuating character of the silver product as a whole is mainly due.

The gold product, which showed a steady decrease during the first part of the decade, increased as steadily during the latter part and had already reached its former level. Whether it continues this increase as a whole is mainly dependent on the gold belt mines, but a fair increase in the product of outside mines may be looked for. The product of silver will probably continue to be small and uncertain.

Production of gold and silver in South Dakota since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$3,305,813	$70,813	1887	2,300,000	540,000
1881	4,000,000	70,000	1888	2,600,000	100,000
1882	3,200,000	175,000	1889	2,900,000	64,646
1883	3,200,000	150,000	1890	3,200,000	129,292
1884	3,300,000	150,000	1891	3,550,000	129,293
1885	3,200,000	100,000	1892	3,700,000	77,576
1886	2,700,000	425,000			

IDAHO.

The State of Idaho in different portions partakes of the physical and geological characteristics of adjoining States. North of the great lava flows of the Snake Plains it is a mountainous region with high, well-watered valleys, similar physically and geologically to the adjoining region of western Montana. South and southwest of the Snake River valley it incloses part of the great basin region of Utah and Nevada.

In the larger valleys of the northern portion are considerable accumulations of gold-bearing gravels, many of which are so situated that they could not have been deposited by present streams, and bear considerable resemblance to the older placer deposits of California. The immediate valley of the Snake river also contains gravel bars rich in placer gold brought down from its headwaters in the Rocky mountains. It is, however, in so fine a state of division that great difficulty is found in saving it by the ordinary processes. The mountains of the northern portion contain both silver-lead and gold ores, which occur both in granites and sedimentary rocks of Paleozoic age. The former class of ores has received the most attention on account of the demand by large smelters for ore of this character, which it has consequently been possible to mine at a profit in spite of the fall in the price of silver. The most important new development during the decade has

been that of the Cœur d'Alene region in the northern part of the State. Its ores though comparatively low in silver are rich in lead, and hence sought after by the smelters. From 1886 to 1891, inclusive, this district is reported to have produced about seven millions (coining value) in silver, and a somewhat larger value in lead. With the stimulus to gold mining that may be looked for as a result of the fall in the price of silver it is probable that more attention will be given to the development of the gold veins of the northern region, many of which are probably valuable and will yield good returns under good management. Already outside capital has been invested in considerable amount during recent years for the purpose of working the larger placers by the hydraulic process, but the returns from such investments are necessarily slow, and in the absence of statistics as to the relative proportion of gold derived from deep and from placer mines in the total product of the State, it is impossible to determine how much influence they have already had upon the product.

In the granites and eruptive rocks of the southwestern portion of the State extraordinarily rich deposits of high grade silver minerals were early discovered and worked; and many of the mines have been since abandoned, apparently in large measure on account of financial complications. These ores are in many respects similar to the rich silver ores which are characteristic of the western Nevada belt. During the decade new discoveries of similar ores have been made in the region, and already the Delamar mines have become large and important producers of silver.

The available statistics of the production of the precious metals during the decade show a slight increase in the gold product with small but not important fluctuations in its amount which may be taken in round numbers at about two millions for the latter half. At least one-half of this product may be estimated to have been derived from placer mines. According to the reports of the Tenth Census the placer mines of Idaho ranked next in importance to those of Montana and California, and what is known of their geological relations give promise of a permanence in their product comparable to a certain extent to those of the latter State.

The silver industry on the other hand has shown a rapid and comparatively regular development, the product of this metal having increased from less than half a million in 1880 to more than four millions in 1889–'90. This development has been materially aided by the building of branch railroads from the transcontinental lines to some of the more important mining centers. This fact and the demand for its ores by the smelters lends a character of permanence to this industry that is wanting in some other regions.

It may be assumed, therefore, that with a continuance of the present low price of silver, although the production of that metal in the State will probably decrease, the amount of decrease will be less than for

many other silver-producing regions, and that when conditions have so adjusted themselves as to assure comparative permanency in the price of silver the mining industry will adapt itself to those conditions and the production of silver become comparatively regular. In the production of gold a fairly regular though probably not rapid increase may be looked for.

Production of gold and silver in Idaho since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$1,479,653	$464,550	1887	1,900,000	3,000,000
1881	1,700,000	1,301,000	1888	2,400,000	3,000,000
1882	1,500,000	2,000,000	1889	2,000,000	4,395,959
1883	1,400,000	2,100,000	1890	1,850,000	4,783,858
1884	1,250,000	2,720,000	1891	1,688,000	5,216,970
1885	1,800,000	3,500,000	1892	1,721,364	4,031,083
1886	1,880,000	3,600,000			

MONTANA.

The precious metal product of Montana has been mainly derived from the granites, Paleozoic limestones, and sandstones and associated eruptives which make up the mountains of its western portion, although the coal beds contained in the Mesozoic strata which underlie the broader valleys and plains in the eastern portion has played an important part in the development of the mining industry of the State.

The mountainous portion of the State has many broad valleys that are characterized by unusually large accumulations of detrital material, many of which have been proved to be highly auriferous. Geological examinations have not yet determined the age of all these gravels, but while a large proportion are undoubtedly recent, it is likely that some may be proved to be of more ancient formation. Their extent and richness have given to Montana a rank next to California in the production of placer gold, and made it during the first two decades of its existence essentially a gold-producing State. During the decade 1880 to 1890 conditions have radically changed. Its silver production has enormously increased, while the gold product, though fluctuating somewhat from year to year, has shown a considerable decrease from the production of earlier years.

In 1880 the gold derived from placers constituted nearly two-thirds of the total gold product of the State; in 1884 this proportion was reduced to little over two-fifths. There are no statistics as to the proportion in later years, but it is known in a general way that placer mining was much retarded by lack of water, and as the gold product as a whole has increased it is evident that there has been a still greater increase in the proportion of gold derived from deep mines. A considerable portion of this gold is known to have been derived from ores carrying both gold and silver; the Drumlummon mine, for instance, whose ores

had over three-fifths their value in gold, have contributed about five millions to the gold product of the decade, but there are mines which have been worked for gold alone, and their number will probably be increased in the future.

To the enormous development of the silver production of the State during the decade, besides the discovery of rich deposits of unusual magnitude, other causes have contributed which have been hardly less important factors in establishing the mining industry on a permanent basis. The first of these has been the rapid development of railroads during this time, so that now the State is traversed by the lines of three large systems, two of which are transcontinental and the third is likely to become so shortly. Not only have the ores of the State been thus brought within reach of outside smelters, but the building within the State of smelting plants and of amalgamation plants of complicated nature requiring a large supply of fuel has been rendered practicable and actually brought about through this agency.

The most important producer of silver has been the mining district of Butte, whose development followed closely on the heels of that of Leadville in Colorado, which it soon rivaled in the magnitude of its product of this metal. Here the analogy ceases, however. The silver ores of Butte contain but little lead, and are mostly reduced by the amalgamation process combined with previous roasting and chlorination, there being only a single smelter which treats them, and this in connection with copper instead of lead. The ores are obtained from a series of strong and large vertical fissures in granite in the vicinity of a recent eruption of rhyolite. While at first silver was the principal product, it has of late years been overshadowed in value by the copper product, coming from a similarly situated and parallel but distinct series of veins which carry but little silver. The total precious-metal product of the district is estimated at about $92,000,000, of which nearly 7 per cent. in value is gold. The silver product reached its climax within the decade, and at its close had already begun to decline. This decline resulted not so much from exhaustion of the ore bodies as from the high cost of reduction, which, when combined with increased cost of mining at depths of a thousand feet or more, soon made the cost of production equal to the declining price of silver. In consequence most of the larger silver mines of the district are at present practically closed.

Outside of this district several unusually large and rich silver-bearing deposits have been developed during the decade, the most important of which is that upon which the Granite Mountain and Bi-Metallic mines have been located, also a strong vertical fissure in granite. The former alone has produced over $14,000,000, mostly in silver, during the decade. The Drumlummon is another important deposit, which has produced over $7,000,000 during the decade, of which less than half the value was in silver. Important deposits of argentiferous galena ores in limestone are also found, but their production is so far less

important than the similar class of deposits in Colorado. Mining development in this State has progressed more rapidly than scientific investigation, and the geological conditions of a great number of its deposits are yet unknown.

The silver product, as shown by statistics, has increased steadily up to the end of 1892, thus proving a considerable increase in the product of districts and mines other than those mentioned above, which at the present time are either closed or working with a greatly reduced force. While, therefore, a very considerable falling off in the silver production of the State is to be looked for, it is not likely to cease altogether under any probable reduction in the price of that metal. Nor, on the other hand, is a moderate rise in that price liable to result in any great immediate increase, for most of the largest known ore bodies have been worked out to such a depth that the starting up of work again means a preliminary expenditure too large to be undertaken without the fair certainty of a permanent price for the product.

The gold output, on the other hand, is liable to increase. Under favorable conditions placer mining will be resumed. A considerable portion of the State is not yet thoroughly explored for ore deposits, and gold-bearing ores will be more sought than formerly, while of already opened deposits work on those that carry considerable values in gold as well as in silver will naturally be continued rather than on those whose values are in silver alone.

Production of gold and silver in Montana since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$1,805,767	$2,905,068	1887	$5,270,000	$15,500,000
1881	2,230,000	2,650,000	1888	4,200,000	17,000,000
1882	2,550,000	4,370,000	1889	3,500,000	19,383,939
1883	1,800,000	6,000,000	1890	3,300,000	20,361,636
1884	2,170,000	7,000,000	1891	2,890,000	21,139,394
1885	3,200,000	10,000,000	1892	2,891,386	22,472,323
1886	4,425,000	12,400,000			

NEVADA.

The State of Nevada has peculiar physical conditions, characteristic of the so-called Great Basin region which extends beyond its boundaries into western Arizona, southeastern California, western Utah, and portions of Idaho and eastern Oregon. These are a very arid climate, a scarcity of running water, and no exterior drainage, except in the portion traversed by the Colorado river, which, however, does but little to relieve it of its desert character. In such a region agriculture is necessarily so limited in its development as to be unable to constitute a self-supporting industry, and, since the inhabitants must necessarily be dependent on mining or pastoral industries, it will always be sparsely populated. It suffers under the further disadvantage of containing on

economically valuable coal beds. Under these circumstances it can hardly expect to have the net work of railroads whose permanence is dependent upon a local population, and which do so much to reduce the cost of working ores in more favored regions; and for mining as an industry to flourish in such a region it is requisite that it should have either exceptionally rich ores or remarkably large concentrations of ore in a limited district. Under such conditions even, the industry is necessarily liable to frequent fluctuations in its product, and such, as statistics show, has been the case with Nevada.

Placer deposits like those found in California, are necessarily wanting in Nevada owing to the absence of large running streams. Its surface is a series of broad valleys separated by narrow and isolated mountain ranges. These valleys have considerable accumulations of detrital material, which is spread out in long gentle slopes from the foothills of the mountains to the middle of the respective valleys. This material is the result of subaerial erosion, and, though metallic minerals are undoubtedly disseminated through the gravel, it would hardly be expected that they would be found to any great extent concentrated into workable deposits. Even if they were so concentrated, it is only under exceptional conditions, as for instance in the southeastern part of the State, that a sufficient supply of mining water could be obtained to work them.

Its mountains are made up of sedimentary rocks ranging in age from the Jurassic back to Cambrian, and of a great abundance and variety of crystalline and eruptive rocks, whose geological conditions have been extremely favorable to the concentration of the precious metals into ore deposits. The greater part of the ores thus far developed have been, especially in the western part of the State, high grade silver minerals, relatively rich in gold, the amount of base metals associated with them seeming to be in larger proportion in the eastern part of the State.

As its development proceeded from west to east, and ores were naturally developed in proportion to their adaptability to amalgamation processes which were first perfected in the West, rather than to smelting, which alone is capable of treating profitably complicated base metal ores, the actual developments may represent rather the result of these conditions than of the relative proportions in which the metals exist in the rocks. Both classes of ore contain a relatively large proportion of gold, while of gold ores proper, that is, those which contain no appreciable values in other metals, the amount discovered has been very limited, and, so far as known, confined to the western borders of the State.

The production of the Comstock lode, which is a fault fissure in eruptive rocks, that has been worked on a length of nearly four miles and to a depth of 3,000 feet, has hitherto overshadowed that of all other mines in the State, having reached in 1892 a total of $350,000,000 in silver and gold in the approximate proportion of 6 to 4. Owing to the great expense of working and the exhaustion of its great bonanzas, its lower workings were abandoned at the close of the last decade, and its production during the present decade has been little more than an eighth of what it was during the previous one. In spite of this greatly reduced production its proportion of the total product of the State has been nearly two-fifths of the silver and over three-fifths of the gold. Its lowest years were 1881 and 1882, but, although in 1891 and 1892 its product was more than double that of the two former years, inasmuch as this product must have been derived from ground that had been already worked over, it can not be expected to continue this rate of production for many years longer, especially with the reduced price of silver.

The Eureka district, in the central portion of the State, which has been the largest producer next to the Comstock, gets its ores, which are largely argentiferous galenas and their decomposition products, from the Silurian limestones. They have to be reduced by smelting, which is rendered expensive by the high cost of fuel, and the district consequently has been among the first to be adversely influenced by the reduced price of silver. The output of precious metals has fallen off from $1,250,000 in 1887 to $630,000 in 1892. The most important mines have stopped all new work, and with a continuation of the present low price of silver the production of the district will probably be reduced to an insignificant amount. The ores carry one-third of their value in gold, and the amount of this metal produced by them during the decade, combined with that derived from Comstock ores, make up all but about $2,000,000 out of the $25,000,000 of gold reported during this period for the entire State. If these two sources of supply of the precious metals become exhausted or cease to produce, the additional stimulus which may be given to the search after and development of gold deposits can hardly be expected to afford any adequate compensation for the loss to our gold product which will result therefrom.

Of the numerous smaller mining districts scattered through various portions of the State, it can only be said that, owing to the high cost of working consequent upon the physical conditions described above, their product has been subject to considerable fluctuations during the decade, and their development as a rule can hardly be said to have become established upon a permanent basis. With a reduced price of silver it is probable that many of them, especially those in the southern and eastern part of the State, which have rich silver-bearing ores in limestone, will be abandoned. The Pioche district, which, prior to 1880, had produced nearly $20,000,000 from its rich silver-bearing lead ores in limestones and quartzites, has lain idle during the entire decade for the reason that its ores can no longer be profitably worked except by smelting, and this is not possible until the district is reached by a rail-

road. Those in eruptive and more siliceous rocks along the northern and western borders may be kept alive by turning their attention to the development of the gold ores which are likely to be found in these regions, but the mining industry of the State, taken as a whole, is liable to be most disastrously affected by a permanent reduction in the price of silver.

Production of gold and silver in Nevada since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$4,888,242	$12,450,667	1887	$3,500,000	$4,000,000
1881	2,259,000	7,060,000	1888	3,525,000	7,000,000
1882	2,000,000	6,750,000	1889	3,060,000	6,236,060
1883	2,520,000	5,430,000	1890	2,800,000	5,753,535
1884	3,500,000	5,000,000	1891	2,050,000	4,551,111
1885	3,100,000	6,000,000	1892	1,571,500	2,901,323
1886	3,020,000	5,000,000			

NEW MEXICO.

In climate and physical conditions New Mexico has a general resemblance to Arizona, but it has a great advantage over the latter Territory in the occurrence of coal-bearing rocks within its borders upon whose existence has largely depended the development of railroads, smelting plants, and other factors that favor the establishment of the mining industry on a permanent basis. Of its geological structure only the most general features are known. The basin ranges extend across the southwestern portion, having, as in Arizona, a general northwest trend and made up of Paleozoic beds resting on crystalline rocks, both of which are traversed by eruptives. The southern end of the Rocky Mountains project across the northern boundary of the Territory, while through the middle portion run isolated ranges with a north and south trend, similar in geological and physical structure to the basin ranges; these become less frequent east of the valley of the Rio Grande and finally disappear in the plain region of northern Texas. In the angle between the northwesterly and northward trending ranges, in the northwestern portion of the Territory, is included a portion of the Colorado plateau which terminates to the southward in a large area of recent lava flows.

The precious metal product of the Territory has been almost exclusively derived from the mountain ranges. Placers have been worked to a certain extent in the valleys of the southwestern part of the Territory, but their output is not known. Rich placer ground is known to exist on the débris slopes of the broad arid valleys to the south of the Rocky Mountains, but they can not be worked without the expenditure of considerable capital in water ditches, and litigation is said to have hitherto stood in the way of their development.

The northwest trending ranges in the western and southwestern portion of the Territory have been the earliest and most permanent producers. Their ores are mostly silver-bearing but carry some gold, and gold ores, reducible by amalgamation, have also been developed. A most favorable indication for mining in this region has been the experience that some base metal ores have greatly increased in gold value below the oxidized zone and been successfully reduced after concentration.

A north and south belt along the west side of the Rio Grande Valley, which reached its climax of development about the middle of the decade, has been the most important factor in the silver production of the Territory. The ores are argentiferous galenas and their decomposition products, occurring in Carboniferous limestones; and their development has been stimulated by the proximity of railroads and the establishment of smelting plants. The fall in the price of silver, which came at a time when the richest ore bodies had mostly been worked out, had a most disastrous effect on the silver production of this belt whose influence is seen in the steady decrease in the product of the metal for the Territory during the last half of the decade. In one portion of this belt is a district in which gold is the chief product, and in which the stimulus given to the development of such ores by the fall in the price of silver has already had the effect of doubling its product.

In the mountains to the east of the Rio Grande valley are several mining districts whose chief product is gold. In spite of the difficulties with which they have to contend in transporting supplies from the railroad 100 miles over a desert country, their product has rapidly increased during the last half of the decade, $55,000 being reported for 1886 and $256,000 in 1892.

It seems rather singular that but little active mining appears to be going on in the high mountains of the Rocky Mountain system near the northern boundary of the Territory, in which from general geological indications it would be expected that rich ore bodies might be found. This may be possibly due to the fact that a very considerable portion of this area is included in old Spanish grants, since confirmed to individual owners, and in which the discovery and location of ore bodies is not as attractive to the prospector as under the mining laws of the United States.

In considering the Territory as a whole it will be seen by reference to the table that the increase of the gold product during the decade has been steady and continuous, and a further and possibly greater increase may reasonably be looked for in the coming decade.

While the silver product, however, shows a considerable increase between the commencement and end of the decade, the falling off in the latter half has been about 50 per cent., or at the average rate of about a quarter of a million per annum. Under existing financial conditions a still further decrease may be looked for, but the entire silver product is not likely to cease since, although silver mining *per se*

may no longer be profitable, a certain amount will naturally be produced as a by-product in the reduction of other ores required by smelters.

Production of gold and silver in New Mexico since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$49,354	$372,337	1887	500,000	2,300,066
1881	185,000	275,000	1888	602,040	1,200,000
1882	150,000	1,800,000	1889	1,400,000	1,461,010
1883	280,000	2,815,000	1890	950,000	1,680,808
1884	300,000	3,000,000	1891	805,000	1,713,131
1885	800,000	3,000,000	1892	950,000	1,075,000
1886	400,000	2,300,000			

OREGON.

In physical and climatic conditions the State of Oregon is divided by the Cascade range into two distinct and strongly contrasted portions. Western Oregon is a rugged and mountainous belt having a very moist climate. Eastern Oregon, which occupies two-thirds of the area of the State, is mostly broad desert valleys with a few mountain ranges toward the eastern border, and has the dry climate peculiar to the interior of the Rocky Mountain region. Of the geology of the State only a few broad general features are known. The rugged region of western Oregon contains representatives of the auriferous slates of the Sierra Nevada, and is supposed to form the geological continuation of that range. The higher portion of the Cascade range is formed of recent lavas, which spread out in places to a considerable distance over the horizontal tertiary beds that fill the broad plains and valleys at its eastern base. The most important mountain range of eastern Oregon, the Blue mountains, is reported to contain Triassic and Jurassic limestones, like corresponding ranges in western Nevada, while granites and metamorphic rocks form the basement complex, underlying all more recent sediments.

The precious metal output of the State is mainly in gold, silver having been produced in comparatively insignificant amount, except at the close of the decade when several important silver mines were opened in the eastern portion of the State, but which have since been closed down.

The gold placers of western Oregon are from the configuration of the country necessarily much smaller than those of California, yet in earlier times they afforded the major part of the gold product of the State. They are still worked on a small scale by individual miners, largely Chinese, and to some extent by hydraulic mining. An interesting variety of placer mine is afforded by the beach sands which result from the disintegration of the gold-bearing rocks along the Oregon coast. A small amount of placer gold is derived from them,

but as a rule they are not sufficiently rich to yield much profit. At the commencement of the decade the product of western Oregon was nearly two-fifths that of the entire State, but in 1890 its product had decreased to half of what it was in 1880, and formed only one-fifth of the State's product. In the former period this product was practically all derived from placer mines, but since then there has been a small but increasing product from vein mining, though what proportion it bears to the entire product is unknown.

In eastern Oregon deep mining had already assumed considerable importance at the commencement of the decade, having yielded nearly one-third of the entire gold product of that portion of the State, while the other two-thirds came from placers. Although the returns of later years are not segregated, it may be assumed that the proportion derived from deep mining has increased, since the product of the entire region has so much increased as to replace the decrease in the production of western Oregon. The greater part of the product of eastern Oregon comes from mines along the eastern edge of the State, the yield of those scattered through the interior having been comparatively insignificant. Although the census figures show an apparent slight falling off in 1890 as compared with 1880, those of the Director of the Mint show an increase and a still greater one in the two succeeding years. A gold yield that depends on placer mining is necessarily subject to fluctuations due to failure or abundance of water supply, and no great permanence can be assured for Oregon's gold yield until it is derived in greater degree from deep mining.

Production of gold and silver in Oregon since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$1,097,701	$27,703	1887	$900,000	$10,000
1881	1,100,000	50,000	1888	825,000	15,000
1882	830,000	25,000	1889	1,200,000	38,787
1883	660,000	20,000	1890	1,100,000	96,969
1884	660,000	20,000	1891	1,650,000	297,374
1885	800,000	10,000	1892	1,400,000	64,646
1886	900,000	5,000			

UTAH.

The generally north and south trend of the Wasatch uplift divides the Territory of Utah into two parts, sharply contrasted geologically as well as topographically, though both possess the generally arid climate of the interior basin of the Cordilleran system. To the east is the plateau country, a region mainly occupied by extensive table-lands with narrow, tortuous valleys in whose bottoms run small streams tributary to the Colorado river that receive their waters from the bordering mountain ranges. The surface of the region is mostly covered by flat-lying beds of Mesozoic and Tertiary age.

On the west of this line is the Basin range province, a region of isolated mountain ranges, separated by broad desert valleys, with no external drainage. In some of these valleys are still found lakes, the partly desiccated relics of larger bodies, whose waters are for the most part so strongly charged with mineral matter as to be unserviceable to man. The mountain ranges are made up of upturned sedimentary strata of Paleozoic age, of older crystalline rocks, and of more recent eruptives; the desert valleys are covered by gravels and clays of Quaternary or recent formation.

At its northern end the Wasatch uplift develops into a broad, high mountain mass which sends down the streams that, under the beneficent irrigation system of the Mormons, have converted the desert valleys into fruitful farming lands.

This is the only part of the Territory that is capable of supporting an abundant population, and is hence necessarily its industrial center. Mining in Utah, which was discouraged by the Mormon church, has only flourished during the last two decades. During the last decade, with the increase in railroad facilities, the development of the coal beds in the plateau region, and the establishment of several smelting works in Salt Lake valley, the output of the precious metals has more than doubled, and in 1891 had reached a total of over $12,000,000.

The Wasatch mountains in which the valuable ore deposits were first discovered still contain the most productive mines, the yield of a single district, and practically of one great vein, furnishing nearly one-half of the total product of this Territory. The ore bodies in limestone, which created the first mining excitement, have yielded but little during the past decade. The product of the great Ontario-Daly vein, which is in Carboniferous quartzites associated with eruptive dikes, has reached twenty-seven millions. Its ores, which are mixed base metal ores, are reduced by amalgamation and lixiviation, and the regularity of its product and of the dividends paid from it have been most remarkable. At its present great depth, owing to excessive flow of water, the cost of mining has increased considerably, but will be reduced upon the completion of the deep-drainage tunnel, which has been driven during the past few years. It is probable that the mine can be worked at a profit with even greater reduction in the price of silver. The bullion produced from the mines of the district carries over 1 per cent. of its value in gold.

The first of the desert ranges west of the Wasatch, the Oquirrh mountains, has rich silver ores and argentiferous galenas, in Paleozoic limestones and quartzites, respectively, which have yielded nearly a million annually during the decade. Although the very rich bodies first discovered are mostly exhausted, the product of the region as a whole has maintained a fairly even grade during the decade, as it has good railroad facilities and a considerable proportion of its ores are smelted. Gold forms a relatively high percentage of its product, being

estimated at about 6 per cent. of the value of the total yield. There are large bodies of low-grade siliceous ores rather difficult to reduce, which can only be worked at a profit where cheap and effective methods of treatment have been devised. The output of this district, which is the third in importance in the Territory, is seriously affected by a low price of silver, though the mines producing ores rich enough in lead or copper to command good prices from the smelters will be the last to be abandoned.

The Tintic district, in one of the desert mountain ranges forming a southern continuation of the Oquirrh uplift, has been the second largest producer during the decade, its annual output varying from $1,000,000 to nearly $5,000,000. The ores are found in Paleozoic limestone, and carry values in silver, gold, and copper, with comparatively little lead, the gold yield averaging about 3½ per cent. of the total value. They occur in immense bodies, and when profitably worked yield large returns, but are difficult of reduction under ordinary methods. The better grades are shipped to the copper-silver smelters in Colorado. Branch lines have been built to the district by two competing railroad systems during the decade. Nevertheless, the character of the ores is such that the yield is extremely sensitive to fluctuations in the price of silver. It reached its maximum in 1890, and has since been falling off. With enterprise and intelligent management, it would seem, however, that in virtue of their contents in copper and gold, a considerable proportion of the product might be kept up even with an excessively low price for silver.

In the San Francisco range in the southwestern part of the Territory large bodies of relatively pure silver-lead ores have been found, mostly in Paleozoic limestones in association with eruptive rocks, and to a certain extent within the eruptive bodies. The most important mine is the Horn Silver, which has yielded in all over ten million dollars in silver, with an insignificant percentage of gold. Narrow gauge railway connection was made with the district at the commencement of the decade, and the ores have been sent East to be smelted. For three years, about the middle of the decade, work in the Horn Silver mine practically ceased, and the product of the district was very small, but with the resumption of work in this mine it has increased again to an annual average of over half a million. This product will naturally be dependent on the price of silver, but, though at somewhat of a disadvantage on account of its distance from industrial centers, its ore may be worked to a profit on account of their lead contents even with a low price for the precious metal.

In the extreme southwestern corner of the Territory, in a band of Mesozoic sandstones known as Silver reef, is an occurrence of silver ore of rather unusual geological character. The ore occurs rather as an impregnation of the sandstone than in well-defined ore bodies. Although of rather low grade, it has been possible to mine and mill it

at a profit in spite of its distance from railroad communications, owing to the purity of the mineral and the ease with which it is crushed. The total product of the district is said to have been over $6,000,000. Its annual product during the early part of the decade was about $400,000, but it has now fallen off to less than $50,000, and is no longer of much economic importance.

Mines have been opened in various other parts of the Territory but no districts have reached the point where they can be considered as permanent producers. Considerable interest has been displayed of late years in a newly discovered district on the edge of the desert near the western boundary of the Territory known as the Deep Creek district. The ore occurs in Paleozoic limestones, is mainly silver bearing, but carries some gold. From $100,000 to $200,000 has been produced during the past two years, but no permanence can be looked for until railway communication is established. In the plateau region in the extreme southeastern portion of the Territory adjoining Colorado, to which it belongs geologically, gold-bearing placers on the Rio San Juan and near the Henry mountains have been discovered in late years, but too little is yet known of the geological relations to form an opinion as to whether they are liable to lead to the establishment of permanent mining districts.

In conclusion it may be said that, while the Territory is undoubtedly possessed of great wealth of the precious metals, much of which is as yet undiscovered, from the fact that the principal values of its ores are in silver, production is likely to be seriously curtailed by a permanent decrease in the price of that metal. The development of the unexplored parts, which is rendered difficult by their desert character and the want of knowledge of their geological structure, will be further discouraged by a decrease in the prosperity of those already developed.

Production of gold and silver in Utah since 1880.

Year.	Gold.	Silver.	Year.	Gold.	Silver.
1880	$295,747	$3,068,614	1887	$220,000	$7,000,000
1881	145,000	6,400,000	1888	290,000	7,000,000
1882	190,000	6,800,000	1889	500,000	9,030,305
1883	140,000	5,620,000	1890	680,000	10,345,454
1884	120,000	6,800,000	1891	650,000	11,313,131
1885	180,000	6,750,000	1892	660,175	10,472,727
1886	216,000	6,500,000			

WASHINGTON.

The climatic and physical conditions of the State of Washington closely resemble those of Oregon, it being divided by the Cascade mountains into a humid coast belt on the west and a dry interior region on the east. A large plain area occupies the central portion of the interior or eastern division, which is surrounded by mountains that extend into it from adjoining regions. Of the geology of the State even less is known than with regard to that of Oregon. The western belt contains valuable coal beds, which have received considerable development during the decade owing to the demands made upon them by railroads and steamers, but no output of precious metals has been reported for this portion of the State. The Cascade range proper, which is largely made up of recent lava flows, has also yielded no ore bodies, but in its outlying eastern spurs rich gold ore bodies are said to have been found in eruptive rocks, which are probably of more ancient date than the lavas. The gold product of the State, though showing a creditable increase during the decade, is still very small and largely derived from small placer mines, the working of which is rendered easy by the abundant water supply afforded by the many considerable rivers and streams throughout the State. Deep mining was apparently only taken up toward the close of the decade and up to the present time its principal development has been in the northern and eastern portion of the State, in deposits that yield mixed ores carrying values in silver and gold, or silver alone.

The eastern slopes of the Cascade range have yielded gold alone, and the northern slopes of the Blue mountains of Oregon both gold and silver. The entire silver product of the State has been inconsiderable, being not more than half that of gold, and has already fallen off very sensibly with the drop in the price of silver. It is from the development of gold vein-mining that a permanent increase in the mining industry of the State is to be looked for, and what little is known renders it fairly probable that such mining may prove profitable in the future.

Production of gold and silver in Washington since 1880.

Years.	Gold.	Silver.	Years.	Gold.	Silver.
1880	$125,800	$1,019	1887	$150,000	$100,000
1881	120,000		1888	145,000	100,000
1882	120,000		1889	175,000	103,434
1883	80,000	500	1890	204,000	90,565
1884	85,000	1,000	1891	235,000	213,534
1885	120,000	70,000	1892	373,561	193,939
1886	147,000	80,000			

WYOMING.

The precious metal production of Wyoming has thus far been too insignificant to be taken into account. The eastern and middle portions of the State, which were the first to be settled, are great plains of flat-lying Cretaceous and Tertiary rocks, where metal-bearing deposits would not be looked for and which are preeminently adapted for pasturing cattle. The principal industry of the State has, therefore, been pastoral and the mining element in its population extremely limited; it is to this fact rather than to want of natural resources in minerals that the relative backwardness of its mining development is due. The coals

which underlie a great part of its plain areas have been developed only so far as meet the wants of the railroads which traverse its territory. Besides this great source of industrial wealth it possesses valuable stores of petroleum and alkaline salts, all of which form the most substantial foundation upon which to found a permanent mining industry. Within its boundaries, moreover, are large mountain areas which there is every reason to believe will prove rich in the deposits of the useful metals when the discovery and the development of some mining district shall have given the necessary guide and impetus to the work of the prospector, so that they will be thoroughly explored.

Across the southern boundary of the State projects the northern end of the Colorado mountain uplifts in which there has already been a fitful development of precious metal deposits. A few deposits have also been opened in the low east and west ridges running through the middle of the State; but it is to the great mountain area occupying the northwestern corner and covering nearly a third of the surface of the State, which is still practically a *terra incognita*, that one naturally looks for the next important development of precious metals.

At the southwestern extremity of the great Wind River range gold placers have been worked in a small way for many years, and it is from them that the small but relatively steady gold product mainly comes. From what is known of the geological structure of this great range it appears to possess the elements that would favor the concentration of metallic minerals into economically valuable deposits, and it is reasonable to expect that intelligent and thorough prospecting, especially if supported by a fair amount of capital, would result in their discovery. The Big Horn mountains, lying due west of the Black Hills of Dakota which have proved so fruitful a source of gold, are said to resemble the latter in geological structure, and if this is true it might reasonably be expected that an analagous concentration of metallic minerals might be found in them. It is impossible to forecast the probable mineral wealth of a region without some general knowledge of its geological structure, and even this is wanting for the greater part of the mountain areas of Wyoming. Preliminary geological surveys of this comparatively unknown region would be a most valuable preparation for the work of the prospector, and are indispensable for the capitalist. Under systematic and intelligent development, Wyoming, lying as it does between the important precious metal areas of Montana and Dakota, might rival them in time in the value of its gold product, especially in view of the advantage it possesses in its physical structure and already established railroad connections.

THE APPALACHIAN STATES.

Although the existence of gold in the rocks of the Appalachian range was known soon after the discovery of our continent, and the gold-bearing deposits have been mined sporadically since colonial times, less is

definitely known with regard to the geology of the rocks in which they occur or the relations of the deposits themselves than of any other gold-bearing deposits within the United States. It is probable that to this ignorance, combined with a want of technical knowledge on the part of most of those who have attempted to mine them, may in great measure be attributed the many financial disasters that have brought gold mining in this region into disrepute.

They occur along a fairly well-defined belt running northeast and southwest, the strike of the principal geological features of the mountains, in a series of highly metamorphic rocks belonging to one of the as yet undifferentiated pre Cambrian series which until within a comparatively few years were indiscriminately classed as Archean. The ores are found in quartz veins and impregnating the adjoining altered country rock, often in the vicinity of eruptive dikes. The veins as a rule are of rather moderate dimensions as compared with the great quartz lodes of California, but they are often more abundant within a given area, and, within the zone of oxidation, portions of them have proved exceptionally rich in free gold. The configuration and physical character of the country is not such as to favor the accumulation of large bodies of placer gravel, yet occurring as they do in the unglaciated region, the surface material in the vicinity of outcrops of veins, as a result of secular disintegration, is sometimes rich enough to be worked profitably as a placer deposit. When the limits of the zone of oxidation have been reached the sulphuret ores are generally found to be of too low grade to be profitably amalgamated, and this treatment is sometimes further complicated by their association with tellurium; hence mining has in many cases been abandoned while the workings were still comparatively shallow, and the impression has got abroad that gold does not continue in depth.

One of the first essentials for the systematic development of the resources of the belt is a cheap and practical process for the extraction of the gold from the sulphuret ores, and one seems to have been discovered which solves this problem for the ores of the southern portion of the belt.

As shown by the tables of production given below, the precious metal product of the belt is practically all gold, although a few thousand ounces of silver have been produced of late years in the smelting of lead-zinc ores mined in North Carolina. Systematic gold mining can be said to have only been carried on in North and South Carolina and Georgia, the gold product of the other States mentioned having been produced by petty mining and by a few attempts at development in Maryland and Virginia, which have not yet reached the stage of permanent mining. Of the product of the first three States mentioned, which in favorable years has reached nearly half a million dollars, a certain proportion has been derived from placer mines, but the greater part from veins not yet worked below the zone of oxidation; the

product has, hence, been subject to fluctuation. The product of mining in South Carolina, although its aggregate product is less than either of the other two States, is of greater importance to the development of mining industry, as in late years it shows a steady increase resulting from the successful working of sulphuret ores by a comparatively simple process of chlorination, which differs from the many patent processes that have been the curse of the region in that it has been evolved from practical experiment on the ores of one of the working mines, and does not claim to be able to extract more gold from any ore than can be shown to exist in it by assay. This process has already been successfully applied to the ores of other mines in this State, and is about to be used in those of the neighboring States. It is probable that when the geology of the belt becomes better known, and mining gradually falls into the hands of those who possess not only capital but also sufficient practical knowledge of the business of mining to be satisfied with reasonable profits, and who will carry it on in a systematic way and according to scientific rather than charlatan methods, the gold product of this belt will gradually become an important contributor to the nation's wealth.

Production of gold and silver in the Appalachian States since 1880.

Years.	Maryland.	Virginia.	North Carolina.	South Carolina.	Georgia.	Alabama.	Tennessee.	Total.
1880	$2,250	$11,500	$95,000	$15,000	$120,000	$1,000	$1,500	$244,250
1881	500	10,000	115,000	40,000	125,000	1,000	1,750	293,250
1882	1,000	15,000	215,000	25,000	250,000	3,500	250	509,750
1883	500	7,000	170,000	57,000	200,000	6,000	750	441,250
1884	500	2,500	160,500	87,500	137,000	5,000	300	393,300
1885	2,000	3,500	155,000	43,000	126,000	6,000	300	345,800
1886	1,000	4,000	178,000	38,000	153,500	4,000	500	379,000
1887	500	14,600	230,000	50,500	110,500	2,500	500	409,100
1888	3,500	7,500	139,500	39,200	104,500	5,600	1,100	300,900
1889	3,500	4,113	150,174	47,085	108,000	2,629	750	316,250
1890	10,962	6,496	126,597	100,294	101,318	2,170	1,001	354,638
1891	11,264	6,689	101,477	130,149	83,022	2,245	519	332,975
1892	1,000	5,002	90,196	123,881	95,241	2,419	1,006	318,755
Total	42,476	97,910	1,926,244	766,609	1,721,760	44,073	10,226	4,609,298

OTHER STATES.

Of the production assigned in the first table to "other States," the greater part of the silver comes from the western counties of Texas, adjoining the Rio Grande river, where the mountain ranges of Mexico, composed largely of Paleozoic limestones, extend across the international boundary. But little is authentically known of the geological relations of these deposits. Some are said to be free milling—that is, comparatively free from the base metals; others to be associated with copper, and bought by copper-silver smelters. Their development has increased rapidly of late years, but will probably be set back by the fall in the price of silver.

The balance of the "other State" production comes from Michigan,

which for a long time has produced a small amount of silver, and lately has added a nearly equal value of gold to its product. Even less is known of the geological relations of the deposits from which the metals have been obtained in this State. In a general way it is assumed that they occur in the same series of rocks as do the great iron bodies which constitute its principal mineral wealth, and it is fair to assume that if more attention were given to the exploration for precious metals in this region the product of the State might assume considerable importance.

CONCLUSIONS.

In reviewing the production of the whole country for the period under consideration, it is to be remarked that the gold product has remained fairly steady while the silver product has nearly doubled. The average gold product of the country since 1873, as shown by available statistics, has been about $33,000,000 per annum, except during the years when the Comstock mines were in bonanza, to the abnormal yield of which, it is fair to assume, the increased product during the years 1876–1880 was due. The falling off during the first half of the last decade was due to the restriction of hydraulic mining, which in the later years has been replaced by the normal increase from deep mines. It is probable that the increase for 1892 over former years is greater than present statistics show. On the whole, the gold industry may be said to be in a normal and healthy state, ready for a permanent though not necessarily rapid increase, as more capital is intelligently directed to its development.

The increase in the silver product has been phenomenal, especially when it is considered that the yield of the Comstock lode, which during the previous decade constituted about half the total product of the country, has become practically an insignificant factor, and that the average price of the metal itself has steadily fallen during the period, except for the few months immediately succeeding the passage of the Sherman Act; the average price for 1892 having been about 25 per cent. less than that of 1880.

The prime factors in this increase have been the discovery and development of great ore bodies in limestone, such as those of Leadville and Aspen, the ores of which must be reduced by smelting. This has resulted in the building up of the great smelting industry in the West and, in consequence, of an immense increase of railroad facilities, which in turn have encouraged the investment of capital in other mining enterprises. The development of the great veins of Utah, Montana, and the San Juan region, although they produce ores not necessarily reduced by smelting, is nevertheless dependent on railroad facilities which the smelting industry has been the most important factor in developing. In other words, the increase in the silver industry has been due mainly to favorable industrial conditions. If capital had not been invested in

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1884	500	2,500	160,500	57,500	117,000	5,000	300	362,800
1885	2,000	3,500	155,000	42,000	126,000	6,000	300	345,800
1886	1,000	4,000	178,000	38,000	153,500	4,000	500	379,000
1887	500	14,000	230,000	50,500	110,500	2,500	500	408,100
1888	3,500	7,500	139,540	39,200	104,500	5,600	1,100	300,900
1889	2,500	4,110	150,174	47,085	108,069	2,620	750	316,350
1890	16,982	6,496	126,597	100,294	101,318	2,170	1,001	354,858
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railroads and reduction plants, mining would have been confined to the richer ores near the surface, and would probably have been abandoned when these were exhausted; for it has been handicapped during the entire period by the abnormal figures at which the miners' unions have been able to keep the rate of wages, while they have been reduced in almost every other branch of industry.

That the industry as a whole has progressed in spite of a continuous fall in the value of the product has been mainly due to the fact that the larger reduction works, under the spur of the necessity of rendering the large capital invested in their plants productive, have displayed ingenuity and economy in improving their processes and in reducing the cost of fuel and other materials, so as to leave them still a margin of profit. The smaller profit is offset in the case of the larger smelters by the greater number of tons treated, and also by the utilization of other products besides the precious metals, such as lead and copper. As long, therefore, as these larger smelters can obtain even a very small profit, silver mining will be continued in the larger mines and in those whose ore is exceptionally high grade, while the smaller and less favorably situated mines will gradually be abandoned. It is to be assumed, moreover, that self-interest will induce the miners to consent to a reduction in wages when it becomes a question of that or nothing, and thus a still longer lease of life will be given to some established mines in the face of a continuous reduction in the price of silver; but when this price shall have fallen so far, without a counterbalancing rise in the price of lead and copper, that the larger smelting works are obliged to close, silver mining will be abandoned throughout the greater part of the western region. This exigency is not, however, likely to occur while the price fluctuates, as it has done during the past year, between 70 and 80 cents per ounce.

Assuming that silver continues at about these prices, it is probable that the greater part of the silver product of the country will come from Colorado, Montana, Utah, Idaho, Nevada, New Mexico, and Arizona, in the order named, and will gradually be reduced to between thirty and forty millions annually.

The annual gold product, on the other hand, is likely to see a steady increase to $40,000,000, and perhaps beyond, and its principal producers will be the following States and Territories, also in the order named: California, Colorado, Dakota, Montana, Idaho, Oregon, Alaska, Arizona, with a great deal of uncertainty as to the relative rank of the smaller producers.

An industry is of value to the country at large in proportion to its permanence and absence from violent fluctuations, and the silver mining industry has been in this sense of great value. The large amount of capital invested in extensive plants and tributary railroads has given profitable employment to great numbers of people, and assured greater permanence than the many small gold mines and gold-reducing plants.

Its destruction would therefore constitute a serious loss to the nation's industry. It may fairly be doubted, however, whether the course followed by the friends of this industry has been the wisest that could have been pursued, and it seems probable that if no attempt had been made to sustain the price of the metal by legislation, but it had been left to follow the natural course of trade, under the laws of supply and demand which govern the production of other commodities, it would to-day be in a more healthy condition. While its growth and increase of product would have been less rapid, those engaged in it would have been better able to forecast the future course of the price of silver, and would have regulated their investments accordingly.

In regard to the question of a gold or silver standard of value for coinage, it may be argued that a double standard is theoretically impossible, especially for metals whose relative production varies so greatly as has that of silver and gold, both of which have other and varying uses in the arts besides those of coinage. From a purely theoretical point of view the ideal standard would be a metal which is useless for any other purpose than for coinage. The world's experience has, however, failed to find such a metal, though some have been tried.

It is about thirty years since the sudden increase in the world's supply of gold so disturbed monetary conditions as to lead to the advocacy by some wise and long-sighted men of the establishment of silver as the sole standard of value for coinage. That sudden increase was, however, due to a cause that is not likely to occur again in the world's history, viz., the simultaneous discovery in virgin territories on two continents of enormously rich placer deposits.

The recent overproduction of silver, relatively to that of gold, which has led to an attempt to establish the world's coinage on a purely gold standard, is, however, the result of a normal and, for the most part, healthy development of industrial conditions over a long series of years.

That these conditions are at present abnormally disturbed, and that those engaged in the silver industry find themselves in danger of great pecuniary loss, is apparently due, in large measure, to effects produced upon the price of the metal by legislative action. If the natural law of supply and demand be allowed to act freely, and if no attempt be made to control by legislative enactment the ratio between gold and silver, the variations will be less violent and less injurious to the industrial interests based upon silver mining.

If we examine the broader field of the world's production of the precious metals during the period under consideration, bearing in mind the necessary imperfection of statistics, since returns from many countries, such as China and some of the South American States, are at times entirely wanting, we find the annual output of gold fairly regular from 1880 to 1887 at a little over $100,000,000. From 1887 to 1892 (full returns for the latter not being obtainable) there has been a gradual increase to $125,000,000. The greater part of this product

has come from the United States, Australia, and Russia, in the order named, during the first term of years, and in the second term Africa has gradually risen to a nearly equal rank with Russia, while the latter's product has slightly increased.

The world's product of silver for the five years from 1880 to 1884 was on the average about equal in coinage value to that of gold. From 1885 to 1891 it has steadily increased, reaching $185,000,000 in the latter year. The principal silver-producing regions have been the United States, Mexico, and South America, in the order named, to which have been added Australia in the second period, the product of which, mainly coming from the Broken Hill mines, has increased from $1,000,000 in 1885 to $13,000,000 in 1891.

The extent and causes of the increase in the silver production of the United States have already been considered. That of Mexico has increased from similar causes, viz., the increase of railroad facilities, the improvement in reduction processes, and the investment of foreign capital, largely American. Her increase, though less in actual amount, has been greater in percentage, being over 100 per cent. during the period.

The silver product of South America is rather uncertain, owing to incomplete statistics. Its aggregate amount is apparently less than that of Mexico, but exactly how much can not be definitely ascertained. The industry has not yet reached the permanent stage which results from good railroad facilities and settled political and industrial conditions. When that stage is reached, its known wealth in minerals promises a rapid increase in production, but there is no prospect of it in the near future.

In Australia the product of the Broken Hill mines is already on the downward course, and the fall in the price of silver is likely to reduce the yield of that country as a whole to the insignificant amount of earlier years.

It still remains to consider what is likely to be the product of the precious metals throughout the world during the balance of the present decade from the point of view of the geologist and miner, as contrasted with that of the legislator and financier. From this point of view the most uncertain regions are Asia and Africa for gold, Australia and South America for silver.

The gold product of the United States is likely to show, as has already been stated, a moderate and steady increase. That of Australia is at any rate not likely to decline. In Asiatic Russia, which is said to have shown an increase of 9 to 16 per cent. in late years, the product is likely to increase still more with the progress of the trans-Siberian railway now building. This region undoubtedly possesses great mineral wealth, and the gold deposits, whether placers or deep mines, are likely to be the first developed. The most important increase in the gold production will, however, come from South Africa, and what is still more important, this increase will be of a more gradual and permanent character than that derived from California and Australia thirty years since, inasmuch as it will come from deep mines and not from placers. The greater part of the present production is obtained from a conglomerate belt, not unlike in its geological relations to the conglomerate belt from which the copper of the famous Calumet and Hecla mine is derived, and which is considered by some observers to be an old placer deposit like that of the Black Hills of Dakota. Recent borings have proved that this African conglomerate belt continues to be rich in gold at a depth of between 2,000 and 3,000 feet, thus assuring the permanence of its production for many years to come, and justifying the expenditure of capital in its development to an extent that may make its annual product very large. It is, therefore, quite fair to assume as a reasonable probability that the gold production of the world may increase to $150,000,000 within a few years, and possibly to $200,000,000 before the close of the decade.

Silver, which has the disadvantage in respect to gold of being too bulky for actual use as a medium of exchange in large sums, besides being in other respects naturally an inferior metal, is practically valued on a gold standard in all matters of international exchange, whatever value may be given to it within the borders of an individual nation by legislative agreement. The reduction of silver from its ores, as has already been stated, being so complicated a process, silver mining is far more dependent on favorable industrial conditions than gold, and its future development is hence dependent on its gold price. That there still exist, if not in the United States which is probably the most thoroughly prospected country, at least in some part of the world, great bonanzas of silver, comparable in value to the famous Comstock lode, is not to be doubted; but with a low price of the metal they will be less diligently sought after, and even if discovered capital will be more reluctant to invest in them.

If no attempt be made to control by legislative action the commercial course of silver as a metal, its production will doubtless be governed by the same conditions that have applied to copper in the past twenty years, a metal with which it presents many analogies, both in geological relations and physical characteristics. When the production of copper became greater than the ordinary demands of commerce, its price decreased until only a few of the larger and more favorably situated mines could produce it at a profit. These mines were not necessarily the richest; on the contrary, the greatest producers have been mines possessing ores of very low grade, in large quantities, and so favorably situated that they could be worked very cheaply. When the production had fallen into the hands of a few companies, an agreement was entered into by a majority to keep the price up by restricting the production. In spite of its great power and strong financial backing this agreement could not be maintained, and the price has fallen from 25 to 50 per cent. within the last twenty years. It might have fallen still lower had it not been for an increased demand for the metal consequent

upon its extended use in electrical appliances. Although the consumption of this metal in the United States has increased fivefold since 1880, even some of the larger and more favorably situated mines find it advisable to close down from time to time and await a rise in the price; while many small mines, less favorably situated in regard to transportation facilities, have permanently given up the struggle for existence. In the long run, therefore, it is evident the supply of copper must be controlled by the demand, and no certain increase in the price can be looked for until the latter exceeds the former.

With silver there is less chance for the restriction of production, and the creation thereby of an artificial rise in the price of the metal, for the reason that the producing mines are much more numerous and their ownership less likely to fall into the hands of a few individuals or corporations. If, then, the production of this metal be not affected by legislative action or international agreement, it will be more subject to the law of supply and demand than copper. Among producers the law of the survival of the fittest will prevail, and the fitness will be determined by industrial conditions quite as far as by natural supply of ore. There will always be a certain proportion of silver-producing mines standing upon the border land between working at a profit or at a loss. Such mines will close down with a fall in the price of silver below a certain limit, and start up again when its rise above this limit seems to have assumed a reasonable permanence, the limit being dependent on the industrial conditions that prevail in different localities.

Under existing conditions, as already shown, it is probable that the silver production of the United States will show a considerable decrease in the next few years. Probably that of Mexico and South America will be similarly affected, but possibly to a less degree, as their ores are relatively richer, and their mining industry is established on different industrial conditions and somewhat influenced by varying political complications. The product of Australia, as already shown, has already experienced a decrease likely to be permanent under present conditions.

It is therefore reasonable to look for a very decided decrease in the world's production of silver, probably to $150,000,000, or even less if the expected increase in the gold product does not occur. In any event it is only a question of time, and probably not of very long time, when the relative production of the two metals will be about equal, as it was at the commencement of the decade. When in the downward course of the one metal and the upward course of the other the line has been crossed, and the relation between the production of the two metals shall be the reverse of that which now prevails, a decided rise in the price of silver may be looked for, which will render the mines upon the border land again productive, and restore prosperity to the silver industry as a whole.

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TITLE